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JANUARY, 1952

Proceedings

Eastern Regional Conference

NEW YORK SOCIETY
OF
SECURITY ANALYSTS



November 8, 1951

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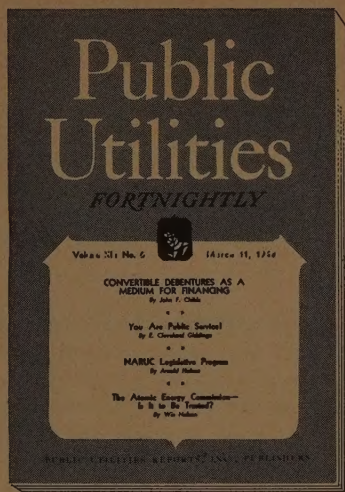
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STATEMENT OF INCOME

Year Ended September 30, 1951

Net sales.....	\$70,006,707
Cost of goods sold.....	51,283,914
Gross profit.....	18,722,793
Selling and administrative expenses.....	8,089,143
	<u>10,633,650</u>
Other income (net).....	226,478
	<u>10,860,128</u>
Taxes on income.....	5,800,000
Net income for the year	<u>\$5,060,128</u>
Cash dividends paid, \$2.50 per share.....	<u>\$2,204,042</u>

CONDENSED BALANCE SHEET

September 30, 1951

ASSETS	LIABILITIES
Cash and Government securities..\$ 7,625,031	Term loan payments—current....\$ 1,100,000
Receivables, less reserve..... 12,033,003	Accounts payable and accruals... 5,371,483
Inventories..... 26,432,593	Provision for taxes on income... 5,945,569
Total current assets.....\$46,090,627	Total current liabilities.....\$12,417,052
Investments in subsidiaries and affiliates..... 4,630,781	Term notes due serially to 1957.. 8,900,000
Plant and equipment (net)..... 7,013,987	Other non-current liabilities.... 392,303
Prepaid expenses, etc..... 660,525	Capital, represented by 881,638 shares of \$1.00 par common stock..... 36,686,565
<u>\$58,395,920</u>	<u>\$58,395,920</u>

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The Analysts Journal

JANUARY
1952

Proceedings

Eastern Regional Conference

New York Society of Security Analysts

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New Developments in Electronics

THURSDAY MORNING, NOVEMBER 8, 1951

LANCASTER M. GREENE, chairman, presiding.

Chairman Greene: Our procedure today is to have the three speakers give their talks and then to permit questions from the floor, with everyone who asks a question identifying himself.

Our first speaker, Dr. Goldsmith, will talk about the over-all picture—and give you a background—of the electronics field.

Our second speaker, Mr. McRae, will talk about the communications end of electronics. And Mr. Finley Carter will then speak covering the impact of electronics on industry and television.

Our first speaker is a native New Yorker. He was born up here on 59th Street and 5th Avenue where the Savoy Plaza is now. It was the old Savoy.

Dr. Goldsmith attended CCNY and Columbia, and later studied under Professor Pupin, the celebrated physicist. He has been a professor of electrical engineering at CCNY, and then an official of GE, shortly thereafter becoming a vice-president and general engineer of RCA.

Twenty years ago he started a consulting engineering business of his own, primarily in the fields of radio, television and color television, and photography, which includes the film industry. He is a past president of the Society of Motion Picture Engineers and one of the three founders of the Institute of Radio Engineers and a past president of that Institute.

It gives me a great deal of pleasure to introduce to you Dr. Alfred N. Goldsmith. (*Applause*)

* * *

Alfred N. Goldsmith: Much as I have been gratified by the invitation from the forum on new developments in electronics of the New York Society of Security Analysts to discuss before you the accomplishments and possible future of electronics methods and equipment, I must frankly admit that only the most superficial coverage of this subject would be possible, even if the entire sessions of the Eastern Regional Conference were devoted entirely to that topic. Perforce, I shall therefore be restricted to mentioning a few high lights and some major objectives of electronic development.

CO-ORDINATE OUR COMMENTS

In addressing you, it is my privilege to be associated with two eminent gentlemen of high professional qualifications. Since both of them are numbered among my friends, it has been possible somewhat to co-ordinate our comments so as to avoid any serious duplication. I shall endeavor to cover the field broadly, and I believe each of them will give you further and instructive details on an important segment of the growing art and industry of electronics.

Broadly speaking, electronics is that branch of elec-

trical engineering which employs certain formerly unconventional circuit elements such as vacuum tubes, crystal rectifiers and amplifiers, and gas-discharge tubes. Few people have agreed on any exact definition—but the foregoing is sufficient for present purposes.

I shall discuss in outline the three main aspects of electronics that will be of interest to you. First, electronics may act as an extension of, or improvement upon, the senses of man. Second, it may provide an electrical substitute for individual human mental, or physical, procedures. And, third, it offers entirely new possibilities of handling operations that lie beyond the convenient or even the possible capabilities of the human brain and hand.

It would be wholly impossible to present to you a comprehensive list of those organizations that have carried forward electronic investigations and developed electronic equipment, over and beyond that usually used in such fields as broadcasting and other communications activities. Nor will there be included any mention of the many aircraft companies, and their satellite manufacturers, who have entered extensively into the development and production of electronic equipment specifically designed for aviation purposes. I shall rather restrict myself to the electronic activities of the major laboratories which include, for example, Bell Telephone Laboratories, Electronics Park of the General Electric Company, the David Sarnoff Research Center of the Radio Corporation of America, and the laboratories of both the Sylvania Electric Products and the Westinghouse Electric Corporation.

AVAILABILITY OF ELECTRONIC AMPLIFIERS

If we consider first the utilization of electronics as an extension or an expansion of the senses of man, these are mainly based on the availability of electronic amplifiers. These amplifiers, whether of the tube or of the transistor type, can utilize a small and feeble input and convert it into a far larger accurate copy of the input. Thus the output of an amplifier closely resembles its input but contains far more energy. This at once enables us, in effect, to amplify both sound and light. We are of course all acquainted with the public address systems which produce sound that may cover many acres, or even square miles in the case of the battle systems used for propaganda from airplanes. We also know how a brilliant picture can be produced on the screen of a television receiver from the feeble incoming energy, even though the picture was originally picked up on a dimly lit football field in the late afternoon.

For example a tennis match taking place in Forest Hills was called off because of impending darkness. The audience was unable to see the play, and the announcer stated regretfully that it would be necessary to discontinue the game because nothing further could be seen.

However, the sensitive television cameras were still

picking up the picture faultlessly, and in the home reception the game was entirely satisfactory. So, from the viewpoint of home viewers of television, night had not fallen; but, from the viewpoint of the actual spectators at the game, night had already fallen—a rather peculiar example of the extension of the senses of man by the medium of television.

THE MODERN HEARING AID

On a more prosaic, but humanly valuable basis, the modern hearing aid has brought enormous comfort to numerous persons whose hearing has become impaired. Electronic techniques enable the accurate recording of sound on phonograph disks or magnetic tape and permit as well the reproduction of this sound with excellent quality and any desired loudness. Possibly pictures may similarly be recorded and reproduced one of these days.

THE ELECTRON MICROSCOPE

A more abstruse but humanly valuable application of electronics is the electron microscope. This has extended the vision of man far into the realm of the infinitely little. By its means, the intimate details of human cell structure can be studied, and bacteria and viruses can be made visible in such detail as to afford many valuable medical clues. Possibly the electronic telescope will reach a stage of usefulness one of these days, and will permit far distant stars and galaxies to be examined more readily by the naked eye. It would be possible to prolong this list indefinitely, but the preceding instances sufficiently indicate the astounding versatility of electronic methods and the likelihood that they will find an ever-increasing usefulness in the realms of industry, entertainment, and science.

MAY SUBSTITUTE FOR HUMAN BEINGS

In the second place, electronic methods may substitute for the individual procedures, both physical and mental, of human beings. It is obviously uneconomical to use a man to do a job if an economic and versatile electronic device can flawlessly perform the task. Human beings are too variable—and costly—to be used except where there is no substitute. Among the electronic methods falling in this class are the controlling devices. They cover an enormous range from automatic door openers to precision means for registering the color impressions on high-speed printing presses. One important application of electronic controls is found in the atomic reactor piles. Here cadmium rods, for example, are automatically slid into and out of the pile in such fashion as to prevent the atomic-fission splitup from getting out of control and result in the well-known and destructive atomic explosions. Broadly, wherever a given control is required to maintain an operation or to avoid an undesirable result, electronic methods may properly be considered. Some prove economical and useful; others do not.

ENABLE EVER-VIGILANT SUPERVISION

Electronic devices also enable unfailing and ever-vigilant supervision. The messages of the supervisory equipment can be carried to remote points where the co-ordinating personnel can determine whether anything has gone wrong.

In some cases automatic devices can even rectify mistakes without human intervention.

CONTROL IN HAZARDOUS LOCATIONS

One important supervisory capability of electronics is the watching or control of processes in locations that are either too hazardous or uncomfortable for human beings. For example, the inspection of furnaces is better carried out by a small television camera or other electronic device than by human personnel. The dangers of operation of an explosive-manufacturing plant can be minimized by remote inspection. In the military field, there are locations where an observer cannot be feasibly installed—for example, in the tail of an airplane. However, electronic cameras or measuring devices can be placed in such locations and can carry their messages back to a convenient observation point.

CONTROL OF COMBUSTION

Another instance of the inspection of a remote effect of similar nature is the location of an electronic camera at or near the top of a smoke stack to watch the control of combustion. Telemetering—the reading of measurement indications at a distance—is another obvious use for electronics.

There are many operations in manufacture where electronic supervision will ultimately relieve much of the tedium or reduce the necessary number of persons involved in an inspection job. Actual or impending failure of equipment can thus be supervised or even predicted and avoided.

GUARDING AGAINST INTRUSION

Still another useful application of electronic methods is the guarding of plants or installations against unauthorized intrusion. Light beams and photocells, with associated amplifiers, warning circuits, or alarms, can surround any area with an open and yet impenetrable barrier. In such cases intrusion automatically gives the necessary alarm.

COMPUTING MACHINES

One of the most startling successes of electronic devices has been in the realm of the computing machines. It has been found possible to build machines that, in the flash of a second, will carry out, with a high degree of accuracy, a calculation that might take many skilled mathematicians weeks or even years.

COMPLEX MECHANISMS

These electronic computers are today rather large and complex mechanisms. However, their capabilities are astonishing. They are used, for example, to calculate the ephemeris—that is, the navigational tables issued by the Government for the use of marine and air navigators. Computers can similarly be used in normal business and industrial operations, for bookkeeping, inventory control, and a myriad of other necessary applications. In the military field their applications are also legion. On the one hand, they will compute the trajectory or path of a missile, for example, a shell directed against a distant airplane. They can predetermine the performance of an airplane having various selected modifications of design, thus saving much time and enormous sums of money. The so-called

fire-control or gun-directing equipment can even aim the gun and set the fuse of a shell automatically so that the shell and the target will arrive at the same point at the same time.

It is permissible to say that the electronic computer is a permanent part of our civilization—and a most valuable one.

FUTURE APPLICATIONS

In the third place, it has been indicated that there are numerous conceivable future applications of electronics, some of great human significance and others of less basic nature. Only a few among the many of these can be here mentioned. And, in any case, any such crystal-ball commentary must be accepted mainly in a broad sense.

AUTOMATIC SHOPS AND FACTORIES

It is likely that automatic shops and factories will some day be evolved. We already have Automats where the customer deals with rather simple machinery to secure his necessary nutrition. The principles of the Automat can likely be developed further in the direction of comfortable and satisfactory automatic restaurants. Similarly, the flow of materials through a manufacturing plant and the processing of such material may in time be increasingly simplified and rendered automatic by electronic machinery and controls.

IN THE MILITARY REALM

In the military realm electronics is playing an increasing and almost alarming, role. Its uses in the production of the atomic explosives are myriad. In the modern long-range bomber, the electronic equipment that is installed may cost more than the remainder of the bomber. When guided or homing missiles are considered, their entire functioning depends primarily on electronic apparatus.

I am, of course, referring to the dream of the push-button war. While it has been said that today we have only the pushbutton, yet the time is rapidly approaching when a great deal of warfare will be controlled by at least a succession of pushbuttons.

WEATHER PREDICTION

One interesting possible future application of electronics is in the realm of precise prediction of future weather at a given location. In order to determine with a high degree of certainty just what the weather will be at a given time and place, an enormous number of variables must be automatically measured, co-ordinated at a central point, and utilized in many and complex computations. In fact, the computation of tomorrow's weather on a reasonably exact basis might involve tens or hundreds of millions of calculations. It is obviously useless to gather the necessary information for the prediction of tomorrow's weather if it will take years to carry out the necessary calculations. The weather computer of the future may carry out many millions of computations in an hour or less and thus bring precise weather prediction into the realm of possibility. This would be a great boon to the farmer and even to the city dweller.

Precision clocks were originally mechanical. Today they

are electronic. In fact, there is under intensive development an extraordinarily accurate type of clock controlled in its timing by the spinning of the electrons around some of the atoms in the molecule of such substances as gaseous ammonia. It is amazing to think that tiny electrons, rotating in their invisible orbits, can act as a balance wheel, so to speak, of a superaccurate clock.

RESEMBLANCE TO HUMAN BRAIN BEHAVIOR

A study of electronic circuits and their behavior has revealed certain curious and significant resemblances to the behavior of the human brain and the controlled nerves and muscles. The study of animals having mechanisms resembling those of electronic devices has been termed "cybernetics". This new science has already been carefully studied by advanced mathematicians, physicists, and electricians. Its findings may go far to explain normal mental and physical processes in animals, and even the peculiar mental aberrations that are sometimes found in man and also, oddly enough, in faulty electronic devices such as computers.

REQUIRE COFFEE IN THE MORNING

I may say, digressing for a moment, that the high-grade computing machines practically require their coffee in the morning before they are ready to go to work. The coffee, however, is not a liquid coffee. It is heat, electric power, applied for a certain time.

When a complex computer is first turned on after a long rest and from a cold condition, its alarm indicators would show malfunctioning, might light up as red lights or sound alarms; and then, gradually, as it heats up and becomes accustomed to its hostile surroundings, the computer alarm lights begin to shut off. And the computer, having had, so to speak, its electrical coffee in the early morning, consents to go ahead with its job and overcomes its original ill nature and errors. The resemblance there, cybernetically speaking, is very obvious. (*Laughter*)

ELECTRONIC CHESS PLAYER

On the lighter side—though with a serious background—it is now possible to build an electronic chess player who can take on the average human opponent and at least hold him to a draw. Perhaps the future electronic chess player will prove invincible even to human world champions in that field.

GUIDING THE BLIND

Of human value would be an effective and simple electronic device for guiding the blind. One approach to this has involved using sounds to give warning of obstacles. That is, the blind man carries the device which throws an interrupted light beam, for example, ahead of him. If it strikes an obstacle and is reflected, the blind man hears a sound in his headphone and is accordingly warned. Such devices may ultimately be developed to full practicality.

ELECTRONIC AIR CONDITIONERS

Only recently, a major industrial leader proposed that electronic air conditioners be devised. These would permit direct cooling by some as yet unevolved electronic means.

Since comfort in home and working places is important to human beings, this may ultimately constitute a major field of manufacture.

I have not mentioned such applications of electronics as communication over wires, submarine cables, land cables, and radio-relay stations. Nor have I mentioned such other applications as radar, radiobroadcasting, and television broadcasting in monochrome and color. I believe my colleagues on this forum will present adequate and useful information on certain of these subjects and will also discuss certain inherently electronic devices used in the home and industry with which I have not dealt. However, I believe that even my brief summary should prove adequate to clinch the thought that the field of electronics is of major human importance and bids fair to be one of the valuable assets of mankind. (*Applause*)

* * *

Chairman Greene: Dr. Goldsmith's computer is marvelous.

Our next speaker was born in Vancouver, British Columbia. He went to the University of British Columbia and then to the California Institute of Technology, and has been with the Bell Laboratories since 1937, except for four years when he was in the Signal Corps.

He began in the research department and in 1949 went into the development area of Bell Laboratories' work and became vice-president in charge of the Bell Laboratory System's development organization.

He is on the board and on the executive committee of the Institute of Radio Engineers. It gives me a great deal of pleasure to introduce to you Mr. J. W. McRae. (*Applause*)

* * *

J. W. McRae: Ladies and gentlemen, Mr. Chairman, guests: Dr. Goldsmith has given you a broad view of electronics. Now, by way of contrast, I should like to focus your attention for a few minutes on a single industry—the telephone industry. Let us consider two questions: What has electronics meant to telephony? What is its present role? From this look at the past history and the present status of electronics in telephony, we may be able to draw some conclusions concerning its likely future.

STARTED WITH DEFOREST'S INVENTION

Dr. Goldsmith has already defined electronics. In terms of his definition, it all started in the first decade of this century with deForest's invention of the audion. deForest's audion was the first vacuum tube, but for some years the audion was sadly lacking in the quality of its vacuum. An appreciable amount of gas remained inside the tube even after it had been pumped with the best of the standard techniques of that time. Consequently, the audion was a tricky and unpredictable device, its most obvious use being to detect radio signals.

In 1912 its possibilities as an amplifier were recognized, and concerted efforts were initiated to learn how to make a really high-vacuum vacuum tube. One of the results of these efforts was the first transcontinental telephone line. After some preliminary trials, it went into service in 1915

between New York and San Francisco and used 12 vacuum tubes, especially made for the job — located at three points along the open-wire line. Thus electronics entered telephony.

NATIONWIDE TELEPHONY

We should pause at this point and notice the particular need of telephone that was satisfied thirty-six years ago by electronics. The need was the extension of the range of telephony to a nationwide service. The problem faced by the vacuum tube was that speech signals, traveling along a telephone line, become progressively weaker and weaker as the length of the line increases. Something was needed that could make the weak signals stronger—amplify them—at intervals along the line. This the high-vacuum tube could do—and do better than any of the alternative types of amplifier then under study.

NUMBER OF TUBES MULTIPLIED MANY TIMES

From that humble beginning involving 12 vacuum tubes in 1915, the number of vacuum tubes used in telephony has multiplied many times. Now there are well over 2 million vacuum tubes in the Bell System alone. The growth in recent years has been particularly striking, the number having about tripled in the last ten years. The original contribution to long-distance telephony has been joined through the years by additional services made possible by electronics. I shall mention just four examples. In 1927 Transatlantic radio-telephone service was inaugurated, and in 1929 this service was extended to ships at sea. In recent years mobile telephone service to automobiles and railway trains has been introduced. All these radio services have depended on the vacuum tube. So do the two new Havana-Key West submarine cables which provide facilities for 24 simultaneous telephone conversations between the United States and Cuba.

DIFFICULTY AND EXPENSE OF REPLACEMENT

In that situation we have 18 vacuum tubes lying at the bottom of the ocean. The principal problem involved was the difficulty and expense of replacement of a vacuum tube if one went out of order. Most of them are under about a mile depth of water. For this reason, extreme care was taken in the design, manufacture, and testing of these tubes and all the other components in the system.

The objective was twenty years of life for the vacuum tubes and everything else at the bottom of the sea. The cables have been in service now for a year and a half with no obvious signs of deterioration. But I am very sorry that you will have to wait eighteen and a half years before we can give you a report of our success, if indeed we have one.

I shall have a little more to say about these submarine cables in a few moments—but first let us return to long-distance telephony within our continent. Electronics has made possible a kind of mass production in this area. For a good many years only one telephone conversation could be carried on a long-distance wire circuit. During the '20's techniques were developed that made it possible to handle 3 or 4 conversations over the same wire circuit. In the '30's this figure was increased to 12, even to 16 in some cases, and the capacity of each pair of wires in a cable was

similarly multiplied by 6. Just before World War II, the coaxial cable came into use, with 6 or 8 coaxial pipes built into one cable. In this system, each pair of coaxial pipes can carry 600 simultaneous telephone conversations. Even if 2 of the pipes in an 8-pipe cable are reserved as spares, the remaining 6 pipes in the cable have a capacity of 1,800 simultaneous conversations.

RESULTS OF MASS PRODUCTION

This mass production of telephone circuits has had the results we normally expect of mass production in industry—lower costs and greater use and demand. The history of the development parallels remarkably the history of mass production in manufacturing industries. Just as present automobiles and highways could not be visualized thirty years ago, so the coaxial cable system could not have come in the beginning, even had we then known how to bring it about. The demand it now satisfies did not then exist; there were no routes required to handle such a volume of long-distance calls. The gradual introduction of better and better cost-saving techniques over the years has helped stimulate demand and thus given greater opportunity for further mass production.

NEW COAXIAL SYSTEM

Developments along this line have not stopped. A further step is now in the trial stage and will probably start going into commercial service within the next two years. This is a new coaxial system which we expect will triple the capacity of the present coaxial cables. A single pair of pipes should then have a capacity of 1,800 rather than 600 telephone circuits. The 8-pipe cable should have a corresponding capacity of 5,400 simultaneous conversations.

MICROWAVE ELECTRONICS

Also during the last few years a new branch of electronics—microwave electronics—has given long-distance telephony an entirely new kind of facility. This is microwave radio relay, which passed an important milestone in its progress with the opening of the transcontinental radio-relay system for handling telephone calls on August 17, 1951.

All previous telephone lines had to have a pathway of copper—copper wires or copper coaxial pipes—extending without a break along the entire route. True, radio circuits like those linking us to overseas telephones can bridge space without wires or cables. But these radio links can handle only a few simultaneous calls. Microwave radio relay is the first long-distance telephone facility capable of mass production of telephone circuits without the continuous pathways of copper. Relay stations spaced 25 or 30 miles apart beam telephone conversations through space from one station to the next. One hundred and seven of these stations span the continent from New York to San Francisco. They are designed to have an ultimate capacity of about 2,500 telephone circuits. Like coaxial cable, they can carry television programs as well as telephone conversations. This was first demonstrated on September 4, when President Truman was televised over a nationwide television network as he opened the San Francisco treaty conference. In either coaxial cable or radio relay, one television

picture requires the facilities that could otherwise be used to handle between 500 and 600 telephone conversations.

IMPROVEMENTS IN VACUUM TUBES

Electronics could not have made possible all these advances without great improvements in the reliability of vacuum tubes and their associated components. The useful life of the first vacuum tubes was measured in hours. Present telephone tubes, serving 24 hours a day every day, last many thousands of hours. Many of the more than 2 million tubes now in use will have a life greater than ten years. In some special cases the importance of achieving such long-life tubes is of extreme significance: for example, the difficulty and expense involved in replacing one of the 18 vacuum tubes lying at the ocean bottom in the latest Key West-Havana cables, which were designed to meet an objective of twenty years of life.

You will have noticed that my remarks so far have been directed primarily at the use of electronics in producing long-distance circuits. This is only a part of the over-all problem of telephony. Other parts include the telephone instrument on your desk, the wires connecting it with the central office, and the machinery for connecting any two telephones together over a talking path. We could debate whether or not these parts of telephony are "electronic," but, since they use only a relatively few vacuum tubes, I am calling them nonelectronic for the purposes of this discussion. Even without extensive use of electronics, advances toward better service and lower costs of operation have been made in all these aspects of telephony. New telephone sets, descriptions of which you have undoubtedly seen, and greater mechanization of central offices are illustrations of these advances. Dial telephones now constitute more than three fourths of the total number of telephones in the Bell System. As you know, a much greater number of local and short-haul toll calls can be dialed today than ever before. Perhaps it is not so much a matter of common knowledge that your toll operator often dials directly the number you are calling in a distant city. In fact, more than one third of all tollboard calls are now operator-dialed.

This fact brings up a question: If operators can dial toll calls, why should not the subscriber dial them for himself? One problem here is the calculation of the charges for the call. If no operator were involved in each call to record the facts about it, how could the subscriber's bill be made out? A new type of mechanized system called Automatic Message Accounting will probably provide the answer to this question. The machines comprising this equipment are connected to a central office so that they can record and remember all the facts about each telephone call necessary to determine the charges. Then other machines at an accounting centre serving several central offices compute the charges for each call, assemble together all the calls made by each subscriber during the billing period, and finally print the toll message statement to be sent the subscriber. Such machines are now in use in 50 communities in the United States; they serve almost 400,000 customers and record and process about 110 million messages per year.

One such community is Englewood, N. J., where an interesting experiment was to start November 10. Many

Englewood subscribers would then be able to dial, not only nearby communities, but also 11 distant communities: Oakland, San Francisco, Sacramento, Chicago, Milwaukee, Detroit, Cleveland, Pittsburgh, Boston, Providence, and Philadelphia. Bills for calls to these cities, as well as toll calls to near-by points, would be calculated by Automatic Message Accounting machines. The results of this experiment will be of great value in determining the future possibilities of customer toll dialing.

WILL NOT GIVE ALL THE ANSWERS

It will not give all the needed answers, however. For example, the Englewood customer would have to dial more than the 7 digits that suffice to reach any Englewood customer or any other customer in Northern New Jersey. The reason for this is that there are not enough 3-digit central office designations to go around for the entire country. Since there may be a Market 2 office in Newark and another Market 2 office in San Francisco, something more is needed to give each telephone customer a distinctive national telephone "address." We do this by assigning a 3-digit toll area code to a state or part of a state. If, then, the Englewood customer dials MA2-1234, he will reach a customer in Newark, but, if he precedes the number with the toll area code, for example 318-MA2-1234, he will reach a customer in San Francisco. This imposes an added responsibility on the Englewood customer in placing his long-distance call, and one of the things we expect to learn from the trial is how well he can handle this situation.

ALTERNATE ROUTE

In establishing a long-distance call, the toll operator often has an alternate route that she can use in case all the circuits are in use along a part of the normal route to the distant point. The equipment in Englewood is also capable of selecting an alternate route if it finds the circuits on the preferred route in use. For the ultimate mechanized handling of toll calls, even greater facility than is now available is desirable in the way of alternate routing. In another new development, which will get into actual service about the middle of 1952, the machine will be capable of examining successively as many as five alternate routes if the first choice route is busy. This feature, in addition to several other rather technical requirements of the system, is made possible by a new device which is called in automatically on each call at the mechanized long-distance center. In a fraction of a second this device gives the switching equipment a number of detailed instructions on how to complete the call. It does this by consulting its built-in card file and flashing the answers to the equipment asking the question, and the called customer's bell starts to ring within a matter of seconds after the dialing is completed.

I have made special mention of this machine, not only because it promises to solve a key problem in the further mechanization of toll calls, but also because it will be the first piece of telephone equipment to use the transistor. Although most central office equipment uses relatively few vacuum tubes, this was one place where vacuum tubes would have been used—if transistors had not appeared on the scene. In this case at least, the three-year-old transis-

tor has won out over its forty-year-old competitor, the vacuum tube.

Since the transistor is one of the newest electronic developments, we should examine its further possibilities in telephony. Does it threaten to replace vacuum tubes in all their present uses? Or is it likely to supplement the vacuum tube by performing functions in which the vacuum tube has been unable to compete. Of course no simple "yes" or "no" answer is possible to either of these questions. The future will contain some of each, some replacement of tubes and some extension of electronics. And we have seen how long it took for the present uses of vacuum tubes in telephony to evolve and how difficult it would have been to predict the present state of the art thirty years ago.

SOME INTRIGUING POSSIBILITIES

But certain facts are worth discussing, for they point toward some intriguing possibilities. First, let me remind you that the transistor is tiny and naturally rugged. It consists of a single piece of germanium with three wires connected to it. Germanium is an unfamiliar chemical element—it looks like a metal, but it conducts electricity in a way quite different from what metals do. We can change its electrical properties markedly by changing its degree of purity. Only a few parts per million of the right impurities suffice to produce important changes in its electrical properties. The significant fact, from our point of view, is that, by putting the right amount of impurity in the right places in a small piece of germanium and then making the three connections to the three wires properly, we can make a transistor. And this transistor is an amplifier like the vacuum tube.

AMPLIFIER NOT A VACUUM TUBE

It is an amplifier, but not a vacuum tube. It is not only tiny and naturally rugged; it also gives promise of longer life since there is nothing in it that is likely to wear out. However, some defects may yet turn up that will limit life and reliability—we cannot be sure of this advantage for several years to come. We can, however, be sure of one advantage. There is nothing to be heated, like the cathode in a vacuum tube. A typical vacuum tube requires one watt of electric power just to heat its cathode red hot.

The cathode must be red hot to boil out the electrons the vacuum tube uses. But the heating power is wasted in the sense that none of it goes into the signal being amplified. Instead, it is all lost as heat—part of it necessary to heat the cathode, it is true—but all this heat eventually must find its way out of the tube and into the surrounding equipment and space. In some applications this has been a serious deterrent to the use of vacuum tubes.

ADVANTAGE OF THE TRANSISTOR

How much advantage does the transistor promise in this respect? I have said that a typical vacuum tube absorbs one watt of power just to put it into business. This would not be much power if we were comparing the tube with, say, a 100-watt lamp. But the lamp's function is to produce light, whereas the telephone vacuum tube is supposed to amplify a telephone signal. To get an idea of its effi-

ciency we have to consider how big is a telephone signal. How much power is needed to produce comfortably loud speech in your telephone receiver? Only about a millionth of a watt! To ask a typical vacuum tube to amplify a signal this small is like sending a 12-car freight train to fetch a pound of butter. Even the smallest subminiature vacuum tubes made commercially take so much cathode heating power that using them to handle a microwatt of signal is like sending a 10-ton truck to fetch the same pound of butter.

EFFICIENCY OF THE TRANSISTOR

Of course, it is often convenient for us to amplify telephone signals to higher powers, but what I have said dramatizes a very real advantage of the transistor—its efficiency. It can amplify a small signal with a total power input only a few times larger than the signal. This will have most effect in two kinds of situation. The first involves concentration of great numbers of tubes or transistors in one room as they would be used in one of our central offices, or in any other complex electronic machine such as a large computer. Even now, some telephone offices and the larger electronic computers have to be specially ventilated to carry away the heat developed in assemblies of many vacuum tubes.

LARGE RATE OF TUBE REPLACEMENT

Another problem is the large rate of tube replacement, which should be alleviated if transistors live up to their present promise of long life. The second kind of situation in which the transistor's efficiency should pay off is that in which amplifiers handling only a few telephone calls are located some distance from a central office. Vacuum tubes have been at a disadvantage in such service because the amount of traffic handled does not justify the difficulty and expense of getting power out to the amplifier. Transistors may help us to devise economical methods for getting greater use out of our existing local wires and cables.

Summing up, it seems to me that transistors will find uses in the central offices, in the wire network spreading out from the central office to subscribers' telephones, and possibly even in the telephone set itself. In none of these parts of the telephone system has the vacuum tube been playing an important role.

On the other hand, in regard to the mass production of long-distance circuits, the vacuum tube may well reign supreme for some time. Transistors cannot operate, at least so far as now known, at microwave frequencies, nor do they at present have the necessary characteristics for handling many hundreds of simultaneous calls. If we remember that this is the telephone field in which vacuum-tube electronics has concentrated, it looks as though the transistor will open up new fields for itself, supplementing rather than replacing the vacuum tube. The future should see the gradual extension of electronics—transistor electronics—to other parts of our Nation's telephone system. You may be sure the telephone industry will work hard to secure the benefits that this may make possible. On the other hand, it took a long time for us to reap the present benefits of the vacuum tube, and so we should not expect any overnight developments. The vista of the future is at-

tractive, but time, thought, and hard work will be needed to reach it. (*Applause*)

* * *

Chairman Greene: You see our eminent scientists are very practical men, and they know how to time time as well as all the important features.

Our next speaker was born in an independent southwest empire which is sometimes thought of as one of the forty-eight states—Texas—in the town of Elgin in 1910. He studied at Rice Institute where he was graduated in 1922 as a bachelor of science in electrical engineering. He then went to General Electric at Schenectady and worked in radio transmitters and receivers until 1929. Then until 1932 he was with United Research, a part of the Warner Brothers' picture company.

In 1932 he joined Sylvania as chief engineer of the radio tube division. From 1941 to 1944 he organized the industrial relations department for that great war expansion. In 1946 he became vice-president in charge of engineering, which is the position he now holds.

It gives me a great deal of pleasure to introduce to you Mr. E. Finley Carter of Sylvania Electric Products. (*Applause*)

* * *

E. Finley Carter: It is a distinct pleasure to speak to you today, in company with such highly qualified men as Dr. Goldsmith and Dr. McRae, on new developments in the electronics industry. I am taking a rather broad view of the term "new developments" so as to include new business developments as well as new technical developments. I hope to show you the effect of several important trends in the electronics industry and how they will probably affect the industry's future.

COURSE INDUSTRY HAS TAKEN

You have been told that we consider the electronics industry to embrace the development, design, manufacture, and sale of equipment employing devices such as vacuum tubes, crystal rectifiers and amplifiers, and gas discharge tubes, as well as components used primarily in such equipment. You have also been told of some of the new developments that have recently emerged from the industry's laboratories. I intend to describe the course the electronics industry has taken so far and to indicate to you what we may expect to take place in the next few years, based primarily on the presently available developments, but also to a limited extent on other developments that are just beginning to show promise.

Back in the '30's the electronics industry was called the radio industry, and it was but a squalling baby among the industrial giants of the day. Radio receivers along with the broadcasting stations to make them useful were the major products in those days. Small but persistent contributions to other industries were found in the form of electronic control devices. Intensive research on television was just beginning. The military requirements of the war brought many visionary ideas from the laboratory into the factory which was soon mass-producing such equipment as radar, proximity fuses, loran, gunfire computers and con-

trols, and a host of others, as well as a wide variety of communications equipment. The heavy demands placed on this infant industry accelerated its growth and brought it maturity that soon enabled it to take its place among the industrial giants.

TELEVISION PRODUCTION AT HIGH LEVEL

Television because of its immediate and enthusiastic acceptance maintained production at a very high level after the war. In fact, postwar production had risen to close to wartime levels before the impact of rearmament began to be felt.

Now again the electronics industry is called on to manufacture its goods for the Armed Forces. At the same time demand for normal peacetime products is still high. The indications at present are that both demands can be met through expansion of facilities, which is now going on at a rapid pace, and through efficient ways of using materials—barring, of course, an all-out shooting war.

Before any extensive discussion, it is wise to review where present developments stand and then try to look a bit into the future.

A considerable mass of information is available regarding the activities of the electronics industry for the periods before the war, during the war, and since the war, which may be useful in anticipating the future course of the industry. Mr. Frank W. Mansfield, director of sales research for Sylvania and also chairman of the statistical committee of the Radio-Television Manufacturers Association, has compiled this information and has also risked his reputation by estimating what may be expected to take place in the next few years.

This compilation tells us that sales of electronics industry products grew almost tenfold between 1939 and 1944, the peak of the war effort insofar as the industry was concerned. In 1939 sales were \$341 million based on factory sales prices, and in 1944 they were more than \$3 billion. During the early postwar period, in 1947, the sales dropped to slightly over \$1 1/3 billion, still four times the prewar level, and in 1950 they swelled again to \$2 1/2 billion.

There is a pretty good indication of what to expect in the demand for radio and television receivers. Demand will probably drop off to some extent in the next year or two because of the buying wave at the start of the war in Korea and the delay in thawing the freeze on new TV stations. On the other hand, sales of commercial electronic equipment of all sorts will no doubt increase. Above all, we know with some certainty, barring total war, how much money will be spent for defense and what percentage of it will be spent in the electronics industry.

All this adds up to a total estimated factory sales figure in 1953 of more than \$7 billion, compared with the 1950 figure of \$2 1/2 billion and a wartime peak of \$3 billion.

To keep all the radio and television receivers in good operating condition, replacement parts must be manufactured and sold. In fact, the repair part business is quite a sizable one all in itself. The sale of repair parts amounted to \$73 million in 1939, \$95 million in 1944, and \$100 million in 1947. Television, because of the complexity of the circuits used and because of the more stringent performance requirements, caused a sharp increase to \$215 million

by 1950, and it is estimated that this will go to \$580 million in 1953. This represents a 15-fold increase since 1949.

STEADY INCREASES IN BROADCAST REVENUES

Revenues to broadcast stations showed steady increases starting at \$130 million in 1939 and going to \$288 million in 1944, \$374 million in 1947, and \$553 million in 1950. This will likely be of the order of \$740 million in 1953.

OTHER MEASURES OF GROWTH

Other measures of growth are the number of people engaged in the various branches of the industry, and the fraction electronics workers represent of factory workers in all industries. In 1939 there were 93,000 persons working in electronics factories, or 0.9% of all factory workers. The war increased these figures to 425,000 persons, and 2.5%. There was a postwar dip to 195,000 persons, and 1.3%. The wide acceptance of television was responsible for a rise to 290,000 persons, or nearly 2% of all workers. In 1953 it is expected that a new peak of 690,000 persons will be working in electronics plants, bringing the proportion up to about 4%.

OTHER PERSONS IN INDUSTRY

Other persons obtaining their livelihood by direct participation in the electronics industry include those in the distribution and repair of radio and television receivers, as well as those working in both radio and television broadcast stations. This brings the grand total in 1950 to 639,000, and everything points to a total of more than 1 million in 1953.

This is quite an achievement for an industry that started from scratch only thirty years ago.

ELECTRONIFICATION OF MILITARY EQUIPMENT

Also significant is the steady increase in the degree of electronification of military equipment. It is well known that some of our costliest aircraft use electronic equipment costing about as much as the aircraft itself. In 1944 slightly over 3% of all military expenditure was for electronic equipment. There is very good reason to believe that the figure will be about 4 1/2% in 1953. Few other industries can match the contributions of the electronics industry to the defense program, either in amount of equipment produced or rate of growth of contribution.

GOVERNMENT PLANS FOR DEFENSE EXPENDITURE

All I have said so far is based on history and a knowledge of our Government's plans for future defense expenditures for presently developed devices and equipment. This is a fast-moving industry, and we have shown in the past that what seems today to be far beyond any reasonable conception is produced in mass production tomorrow.

Witness radar. Until about ten years ago, outside the laboratory it was confined to the science fiction writer's imagination. Today even small tugboats in our harbors use it as a matter of routine. Loran pinpoints the location of sea- and aircraft in the heretofore trackless seas. It is working day and night in the lanes of commerce in many parts of the world. A few short years ago a favorite dream

of generals in all armies was a shell that would explode when it approached within a few feet of its target. The proximity fuse fulfilled this dream and was produced literally by the millions.

New electronic devices are on the way. Present devices are being improved, some to a very marked degree. Electronics will be able to contribute to an increasing degree to the defense effort. One development that has been badly needed and is now starting in production is a line of very rugged and reliable subminiature tubes that can be incorporated in airborne equipment for inhabited airplanes as well as for guided missiles. Subminiature tubes along with other subminiaturized components lend themselves well to printed circuits and packaged units. These in turn will contribute materially to navigational aids developed under the stimulation of wartime research and will further enhance the safety and dependability of air transportation.

SEMICONDUCTOR DEVICES

Along another line of development, the remarkable semiconductor devices which were mentioned by the previous speakers are of great significance. The transistor promises the means of reducing the size and weight of many types of equipment. In many functions it will perform the same job as a vacuum tube, with considerable improvement in size even over the subminiature tube, and with considerably less dissipation of power and heat. This will be very important in many applications.

The use of semiconductor devices will complement and supplement that of vacuum tubes in radio transmitters and receivers, as well as in both simple and complicated electronic computers about which many of you have undoubtedly heard.

PHOTODIODE

A very tiny light-sensitive device known as the photodiode, and based on an unusual property of the germanium crystal, a semiconductor material, promises to be of considerable value. This device (*indicating*), the photodiode, is almost too small to see. One hundred of them may be placed within an area one inch square, ten in a row, and ten rows of ten. It is used for taking information off business machine tapes. It is especially sensitive to invisible infrared light and may therefore be used for secret communication, for detecting activities in the dark, as an infrared detecting device, and for a multiplicity of usages that formerly required rather large photocells together with amplifiers that took up considerable space.

This (*indicating*) is a conventional germanium diode that is used as a detector. This is another version of a transistor. The earlier transistor was put into cartridge-type construction, and now the higher production will be in plastic enclosures as shown to you by Dr. McRae.

SILICON

Silicon, another semiconductor material and the most widely dispersed chemical element, is being put to increasing use in both military equipment and television receivers. Of course, it must be in a very highly refined condition and not at all like the sand we find at the beach.

Electronic computers have made very heavy contributions to both military and peacetime problems, and still they are in the infancy stage of development. Their great value lies in the rapidity with which they operate. Problems that may take capable mathematicians weeks to solve are solved in a matter of minutes or seconds.

GUN CONTROL IN JET PLANES

One other very important use is in the gun control in fast jet planes where the speed is so great that the normal human reaction time is not sufficient to allow any reasonable accuracy. But a computer can take over and control the gunfire with great accuracy. Of course, time is not involved. A gunner on a fast-moving airplane firing his gun at another fast-moving airplane is enabled to improve his accuracy because such a computer coupled with its gunfire control is not limited by the time of human reactions.

This is just a little indication (*indicating*) of a unit that was made up. It takes 10 or 11 of these little subminiature tubes. It is a decade calculator. I showed it to Don Mitchell once, and he said, "What will it do?"

I said, "It will count up to ten."

He said, "I can count up to ten."

I said, "Yes, but you can't do it in a microsecond."

MANY IMPROVEMENTS IN NEXT FEW YEARS

Many improvements can be expected in the next few years. Computers will become smaller and will have greater freedom from maintenance difficulties. They will undoubtedly represent a large segment of our activities in the electronics industry in the future.

CONTROL OF INDUSTRIAL PROCESSES

Control of industrial processes is bound to increase at an accelerating rate. Electronic instruments will supplant human operators wherever the conditions are dangerous or uncomfortable to persons, or where uniformity and precision beyond human ability are demanded. They will be used extensively wherever they prove to be more reliable and less expensive than mechanical or electrical instruments or human operators. To describe many of these industrial control instruments would take more time than is available.

USES OF RADIO COMMUNICATION

The uses of radio communication will be greatly expanded. Already we are able to transmit to and receive from vehicles moving along the streets and highways, either through the telephone system or through private radio systems. Operators of fleets of vehicles in crowded areas can now keep a continuous check on the locations of their various vehicles.

POTENTIALITIES OF THE INDUSTRY

There are many other things we could talk about, but time is limited, and I am sure you already have a good idea of the potentialities of the electronics industry. It would not be at all surprising to me if in a relatively short number of years the electronics industry should take first place among all industries in the value of manufactured products.

The almost limitless possibilities for the application of electronic devices is rapidly changing the complexion of the industry from one that a few years ago was primarily an entertainment business to one of far broader scope. As a result of the tremendous importance electronics plays in air navigation and aerial warfare, large airplane companies have set up vast electronic engineering organizations and are preparing to manufacture electronic equipment on a big scale. Likewise electronic equipment research and manufacture are playing an increasingly important role within the big business machine corporations. There are also well-known companies whose production is almost exclusively navigation, communication, computing, and control equipment. Other companies of importance specialize in measurement equipment which is required in increasing quantities as the electronics field expands and becomes more complex.

RADIOACTIVE ISOTOPES

No doubt there will be, in due time, an abundance of radioactive isotopes as by-products of the various atomic piles now operating. These will have a great multitude of applications all the way from medical research to the sterilization of packaged food on the production line. As a result, there will be required in large quantities sensitive radiation detectors and meters as well as control devices operated by varying degrees of radiation. Dr. Goldsmith has already referred to the very essential electronic controls needed for the operation and protection of atomic piles. These applications will of course be multiplied as smaller piles are developed for atomic power plants.

WILL CONTINUE TO CHANGE

It is evident therefore that the complexion of the electronics industry will continue to change. Old-line companies in increasing numbers will incorporate electronic operations as essential parts of their businesses. Other companies will continue to be set up for the exploitations of new and potentially important developments, and the basic tube and component manufacturers will continue to find pleasure and profit in becoming acquainted with and serving new customers.

MATERIAL DATA FOR RESEARCH

I hope I have not seemed presumptuous in trying to translate my observations in the expanding field of electronics into material data for your research. To be an interpreter one must understand that from which as well as that to which he is interpreting.

I certainly do not presume to know much about the technique of security analysis but believe that the statistics presented herein might be of some interest to you. The rest of my discussion has been more abstract and therefore may be of little tangible value.

MANY THINGS WE CANNOT DISCUSS

There are many interesting things in the laboratories that we have not been able to discuss because of security. These together with some that have been mentioned will go through a pretty well-established pattern of develop-

GROWTH OF THE ELECTRONICS INDUSTRY

	1939	1944	1947	1950	1953 Estimated
<i>Sales, millions of dollars</i>					
End products (factory door prices)	342	3,064	1,387	2,571	7,191
Repair parts (factory door prices)	73	95	100	215	580
Revenue to radio and television broadcast stations	130	288	374	553	740
<i>Employment, thousands of persons</i>					
Production	93	425	195	290	690
Distribution	43	9	79	125	100
Repair	30	40	49	150	231
Broadcasting	32	42	59	74	100
Total	198	516	382	639	1,121
Employees in electronics factories as % of employees in all factories	0.9	2.5	1.3	1.9	4.0
Degree of electrification in military equipment, %	1.7	3.1	0.8	1.1	4.5
% of electronic products for civilian use	95	10	92	95	36

ment before maturing. It is a pattern that you may have recognized. At any rate it is deserving of serious thought when you are appraising the value of any new development as far as its earning potential is concerned. Conception of new ideas is accelerated during wartime, just as is the human birth rate, and a number of parallels may be drawn. The period of gestation is finite and is often accompanied with difficulty, as is the labor of giving birth to a new development. Then the offspring is dependent for quite a long while, involving considerable cost and nurturing, before reaching the stage where it is an economic asset. Therefore, you should be sure, when you hear of a new idea for which significant claims are made that it can be supported with sufficient capital and sufficient understanding to bring it through the trying stages and eventually result in a product that can be marketed at a good profit.

ADEQUATE RESEARCH PROGRAM

The ability and will to support a wise and adequate research and development program is more than ever essential in this amazingly complex field. This can best be done by companies with a sufficient diversification of profitable products to develop the know-how and the capital to pursue and support a long-range and well-planned program of expansion. Yet there are opportunities, as has been demonstrated in recent years, for men with sound vision and determination to start modestly and progress rapidly in the development of new electronics businesses. In either case I am convinced there is a vastly expanding horizon ahead for the electronics industry. Success or failure will not be contingent upon opportunity but upon the men who choose to capitalize on it. (*Applause*)

* * *

Chairman Greene: Our speakers have managed to condense consistently an immense amount of information into

a very short space of time and to help us in obtaining a broad perspective of a tremendous field.

They have left enough time for us to ask them questions.

Mallory Gray (Massachusetts Investors Trust): I would like to ask the panel, or whoever wants to answer, whether transistors use as many caps as radio tubes do?

Mr. McRae: Yes.

David Fox: Mr. Carter, you quoted statistics indicating expectations of a rapid growth in sales of electronic equipment up to 1953. Could you clarify any further what particular segments would have the biggest growth; that is, would television receivers, radio, or other aspects of it be expanding the most?

Mr. Carter: Quite naturally, and because a good bit of it goes to the war economy, a great deal of expansion would be for airborne equipment, communication equipment for the services, computers, guided missiles, and that sort of thing.

These figures I gave are not in anticipation of a shooting war. They are in anticipation of a normal rearmament program, or things that are now in process. Some of these applications are on expendables, and the quantities would be higher.

I indicated that the television receiver level would remain at about the current rate, depending of course on the possibility of obtaining materials. The added part would be most likely in military equipment and in business machines.

I will not make a firm prophecy, but I have often said that up until not so long ago the major field was entertainment. I believe that within a short time, perhaps within ten years, the industrial applications of electronics will exceed the entertainment applications. Therefore, I have no fear of a little immediate setback that might come in total demand, because I think it is going to expand in all directions.

Justin Jacobs (Lober Brothers): Mr. Carter, I would like to ask you a double-barreled question.

1. Would you care to comment on the practical progress your company has made with panel light?

2. Would you comment on the degree of success you have had in eliminating television glare by surrounding the picture tube with a luminous light?

Mr. Carter: Question one concerns the progress that has been made on panel light, and the other the success that has been experienced in reducing the glare around the television pictures.

I had not intended this to be a forum for discussing any of my own company's products, but that is a pointed question, and, therefore, I will give you a direct answer. As I indicated, in the pattern of any new development, we must anticipate a period through which we work out the "bug" to the point where we finally make the development perfect.

As we might have expected, we ran into some difficulty during the summer period with humidity on a panel light which we had to correct by additional research. We are glad we discovered this in the laboratory before the device was put on the market. We have since found materials

that enabled us to make the cells we needed. Progress is going well. It is still in a development stage but is following a normal pattern.

It will probably be three years before we see widespread application, but the enormous interest shown in it was surprising even to us. Everybody wanted panel lights for some particular application. It is going to take quite a little while even to process the samples.

As for the second question regarding the so-called halo light, all I can say of that is that it is primarily a psychological reaction. We had studies made by psychologists that indicated definite improvement was being made in gradually shading out the light rather than giving contrast. The reaction has been extremely favorable. We have gotten some excellent comments. It seems to be well received.

I cannot give you a plus or minus merger on it, but the reaction has been very good.

Mr. Jacobs: Do you use panel light for the halo light?

Mr. Carter: No. That was the natural conclusion to which one would jump, and it would be an excellent application. But at the present time we are using a fluorescent lamp.

In our press conference, for our demonstration we had very large panel lights. We made them up to about 4 x 5 feet. Of course, the smaller sizes are much easier. But a lot of development is needed there before you will find it in everybody's home. I assure you of that.

Question: I would like to address a question to Mr. McRae about transistors. Who makes them? Also, where do we get germanium?

Mr. McRae: That question has some of the implications—or at least my answer would have some of the implications—in it that Mr. Carter's last set of answers had. Various firms have made various kinds of transistors. I could not mention all of them. I can think of three or four—Western Electric, Bell Laboratories, General Electric Company, Sylvania. Those are about as many as I can remember.

I do not believe the transistors that have been produced to date have been considered as commercial samples for actual use. They have been experimental, for people to get familiar with the characteristics of transistors.

No one is yet making a standard commercial product of the transistor. The first I know of will be the unit for internal sale in the Bell System, which will go into use next year.

Allen Buross: Dr. McRae, could you tell us some of the objections to the use of the telephone wire in, say, the Zenith phone system? I refer to the technical rather than to the economic aspects of it.

Mr. McRae: I do not believe I can answer that question. If the demand and the other economic factors prove it to be worth while, to make the system feasible over telephone wires, I do not see any fundamental objection to it technically.

Mr. Buross: Is it a very costly thing to overcome those technical difficulties?

Mr. McRae: I think I would have to ask somebody who has been more closely associated with it. Undoubtedly,

the Zenith people know more about that aspect of it than I do.

Question: I am going to ask the part of the unanswered question raised before by the gentleman from Philadelphia: Where do you expect to get your germanium, allowing for your market for transistors to develop as economically as Mr. Carter said you might?

Mr. McRae: I am sorry. I apologize. I completely forgot that question. At present germanium comes from zinc and other mining and smelting activities as a by-product.

Various concerns are engaged now in producing germanium. I think the largest supplier at this moment is undoubtedly Eagle-Picher. They are engaged in studying the process to discover what are the ultimate limits of the deposits available in the United States. The Munitions Board and others are also interested in this problem.

Question: Other than property owned now by Eagle-Picher?

Mr. McRae: That is their interest. Of course, the Munitions Board is studying it from a broader point of view. In England germanium is being recovered on an experimental scale from flue gases and from the burning of certain kinds of coal which may, incidentally, exist more in England than they do here.

There are other sources of germanium. However, it is also a problem, so far as we have found, of extracting a very small quantity of germanium from a very large amount of coal or oil, or other material. So this is a difficult problem. So far, however, I think the answer is that for the next three or four years we can see means of eking out the necessary supplies. Beyond that, the picture is a whole lot more intangible.

Mr. Carter is suggesting I give you an idea of how much germanium is used in each transistor.

A piece of germanium is maybe as much as 3/16 of an inch long and 1/16 of an inch in cross section—in each direction. That means that, even if we produced something like 12 million units a year, we would be using in the order of 5,000 pounds of germanium a year—something of that sort.

Richard Cromwell (American Mutual): What are the prospects—or can anything be said about them—for lifting the freeze on TV stations?

Mr. Carter: I wish we could tell. The last I heard was Wayne Coy being quoted that possibly ten more stations may be added next year, and probably ten the following year, even if they get the legal tangle straightened out. But I am not speaking for him. It was just something I read. I do not know anything about it.

Offsetting that, I think Dr. Baker made the comment, "Well, they wouldn't come as slowly as indicated because a lot of transmitters were already built." So, we just hope the freeze will be lifted soon and fast, but we do not know.

Chairman Greene: Do you have any comments on when you think the freeze will be lifted, Dr. Goldsmith?

Dr. Goldsmith: That would require an armory of crystal balls. The freeze started in September 1948 and was supposed to be lifted three months thereafter. Three months became six months. Six months became three years.

There have been alternating groups of announcements of extreme optimism and qualified pessimism. I think that

anyone who could give you any definite answer on whether or not the freeze will actually be lifted in the face of those considerations would be not a prophet. He would be, capable of going into the bookmaking business and making a fortune overnight.

It is impossible to say. The Commission sincerely is endeavoring to work out a procedure that will minimize litigation, disputes, and squabbles, and that will permit the gradual assignment of, first, VHF channels, that is, the existing very high-frequency channels, and the large number of UHF channels.

Figures have been mentioned by industry that list some 80 stations by 1953. But all of those, as I say, are estimates out of the wild blue yonder.

Raymond Frankel (Nathan W. Levin): I would like to ask the speakers what role they see for printed circuits in the future picture. Second, just what might be the limitations on printed circuits' use in electronic fields?

Mr. Carter: I mentioned it in the talk, and I will tell you what little I know about it. It seems to me that it is going to be an excellent means of conserving materials, of highly mechanizing the production of units first, for Government equipment and then, later, for television and radio set designs.

In fact, we expect electronics to help control the uniformity of production by having automatic processes which will come along this line.

I say the future is very interesting and very bright, but, again, it will probably be a ten-year cycle before we find great popularity in receivers made for homes.

Mr. Frankel: What limitations hold back the use of them?

Mr. Carter: I do not know of anything except the ingenuity of the men who design them and lay them out and the developing of the processes. Again, you cannot use them to advantage on a few units that you can wire up much more cheaply, but you need to have mass production. And you must have a degree of standardization of a circuit tree that will allow you to make them in mass production. I think that is the answer.

Dr. Goldsmith: This is not an obstacle so much as an opportunity, because the term "printed circuits" is generic. Circuits that are duplicated by some process may be printed in paintings, printing processes, etching, stamping out from sheets and metal, and the like.

The result is that there is certainly a multitude of processes for automatic reproduction of circuits. And among those it will have to be ascertained which are best for each specific type of circuit current-carrying capacity quantity of manufacture.

It is not so much that there are new principles missing or insuperable difficulties, as that the proper division of the field among so many different methods has not yet been worked out.

Question: Will the microwave relay system make the conventional telephone lines obsolete?

Mr. McRae: I suspect that is my question. Well, the answer is no. I think I gave you a little indication of that when I mentioned the other parts of the new amplifiers and other parts of the system which are now starting their trials, which are intended to triple the capacity of this type

of cable for carrying the long-distance telephone circuits.

You can make a comparison like that. That is, on a first-cost basis, taking the present art, radio relay is apt to cost less on going basis than the laying of a cable along the whole route of a number of telephone channels—2,500 ultimate capacity we are talking about.

The maintenance of the radio equipment is higher and costs more than the maintenance of our older systems.

What the future will bring in reducing costs of maintenance—this, of course, is one of our prime activities in the Bell Laboratories: to keep working on these pieces of equipment so that they become more and more reliable—what it will show concerning relative costs under equal conditions, I cannot tell you. We are going to find that out. But, if you already have a cable in the ground, it certainly is likely to be cheaper to modify the system, to triple the capacity of the cable, than to build an entirely new system—and this is exactly the situation we are in right now.

It is very interesting that, even with the tremendous strides that have been taken, a good many old arts are still economic and valuable. The point is to learn how to use them. We could let our imagination roam along the lines that Mr. Carter was following when he spoke of the antenna on top of the house that received all the entertainment and telephone service, and so forth. But let me point out that that leaves out the electric power that we are going to need in our house.

If we need still to have that distributed by copper wires, another alternative might be to bring all these services into the house on the same wires the power comes in on.

These are answers we will tell you more about twenty years from now.

George Davis: So much information was condensed into such a short period of time that I really think we need some electronic devices to keep up with it. I am just wondering if copies of these prepared talks will be available to us.

Chairman Greene: They are going to be published in THE ANALYSTS JOURNAL.

Mr. Davis: That answers the question. Thank you.

Elliott Farr (Corn Exchange Bank, Philadelphia): I would like to ask whether at the present state of the art, transistors could be substituted for vacuum tubes in the applications that we civilians know about, such as television and radio sets, or does a different type of application exist that it could be potentially used for?

Mr. McRae: I was trying to yield to the expert on home receivers and television. In the first place, the term "substitution" is not really good in the sense that we cannot pick a transistor that has exactly the same properties as any given vacuum tube.

This is very important for two reasons. (1) It is going to take the time of a lot of people working hard to learn a new art of design, to learn new tricks in design, and get the most out of these things; (2) there are many applications in higher frequencies and so on that we at present do not know how to fill with, say, the transistor.

There are functions, I think Mr. Carter would agree, that in due course will be performed in home receivers by transistors rather than by vacuum tubes; but it is rather

difficult to foretell at this stage just what functions those will be and just how extensive they will be.

Remember, this is a very early stage. At the time the vacuum tube was first discovered or invented, nowhere near the interest was shown nor the potentialities recognized that are apparent today in this little baby. Of course, the art is moving faster now, and we will see results more quickly than we did with the vacuum tube.

Chairman Greene: Our speakers have been willing to work overtime so far, but we want to feed them and also give you some information on the future of the market.

Irving Kahn: I wonder if Dr. Goldsmith would be good enough to give us a little of his judgment or knowledge about other semiconductors, perhaps make some reference to selenium and also to zirconium.

Dr. Goldsmith: I am afraid that that is even more in the research and development laboratory stage than germanium which has been very intensively attacked recently. I fear I have nothing in the way of concrete information, except that one or two selenium applications seem to have a good deal of promise, particularly in the television field in relation to highly sensitive cameras, phototubes, and the like. That is about as far as it goes.

Mr. McRae: There is one thing you can say about semiconductors. Semiconductors with germanium, or even with silicon, are not new. In the vacuum tube, the things that have had to do with it have been a lot of other devices, and among them have been copper oxide rectifiers which are widely used in telephone systems, and selenium rectifiers which are used in power systems.

One of the reasons why the germanium field has been a fruitful field for investigation is that we can understand what goes on inside this material. The physicist can understand it a lot better.

The Bell System uses a great deal of copper oxide, as I said, to get the right performance. The copper for this copper oxide has to come from a certain part of the world, almost from a certain mine, and we don't know why.

With germanium and silicon we have a lot better chance of finding out really what is happening, and, therefore, can make better technical progress.

Dr. Goldsmith: But I would like to add that usually an area of ignorance means great opportunities in the future, so that what Dr. McRae has said indicates that, when we find out why a particular mine does the trick, we can expect rapid progress of some importance.

Mr. Carter: May I add just one comment? This field of semiconductors is a very wide field, and I do not know whether the group realizes that the phosphorus in fluorescent lamps is a defect-type crystal and, therefore, a form of semiconductor. There are lead sulfides; there are copper oxides; there are a tremendous number of them. And we are able to apply some of the research that we have made in the study even of phosphorus to the study of these materials that we are working on now; so we know more about germanium.

Chairman Greene: We are very grateful indeed to our three speakers, and now we are going to give them a chance to make their fortunes by letting them learn what is going to happen to the market. (Applause)

What's New in Glass?

THURSDAY MORNING, NOVEMBER 8, 1951

WALTER K. GUTMAN, chairman, presiding.

Chairman Gutman: Please come to order, gentlemen. We have two speakers scheduled to appear this morning. They are Dr. W. W. Shaver of Corning Glass Works and Dr. G. H. McIntyre, vice-president of Ferro Corporation.

Both of these gentlemen were graduated from college and entered their respective companies approximately twenty-five years ago, and they have been with these same companies ever since. They have seen the glass industry and their companies' interest in it develop over this time.

Dr. Shaver was graduated from the University of Toronto and received his doctorate there.

Dr. McIntyre was graduated from the University of Stanford, and he received his doctorate from Western Reserve University.

In a minute I shall turn over the rostrum to Dr. Shaver, who will be followed by Dr. McIntyre. The question period will come after both talks.

Dr. Shaver. (*Applause*)

* * *

W. W. Shaver: Modern glasses and their applications have originated in a new concept of glass, no longer limited to a window, mirror, vase, or goblet, but rather classed as an engineering material available in many compositions with a broad range of physical properties. For timeless centuries glass served man first as a material for his tools and weapons, which he patiently chipped from the naturally occurring volcanic glasses. Later, some ten thousand years ago, when he learned to melt glass, its forms and uses gradually multiplied. However, only in the last fifty years or less is glass becoming recognized in its true character as an engineering material that can be tailored for thousands of products better made of glass than of any other material. During this latter period of time Corning Glass Works carried on a program of research and development in the study of composition and properties of various glasses, in melting and forming methods, and in the design of glass-manufacturing machines. Out of this program have come many glass products which are playing an important part in our modern economy, whether in peace or in war. The value of these products in war is evidenced by the fact that in World War II some three quarters of Corning's production was manufactured under Government priorities. The importance of new products to the growth of the company is indicated by the fact that more than 50% of the total sales in 1950 was in products that did not exist commercially ten years previously.

DEFINITION OF GLASS

Our present discussion will be directed chiefly to the consideration of the broad range of properties possible with this engineering material, glass, and a brief review of some of the products. Technically glass has been defined

as an inorganic product of fusion which has cooled to a rigid condition without crystallizing. Actually glasses can be made using almost all the 98 elements in the atomic table, except the rare gases, taking two, three, or more at a time, so that the possible number of compositions is very large. Practically speaking, glasses are largely solutions of oxides, so that a cubic inch of window glass actually contains more oxygen than exists in a cubic inch of liquid oxygen. Raw materials for most commercial glasses are usually abundantly available. In this connection it is interesting to note that, by fusing together the average composition of the earth's crust, excluding hydrogen, a reasonably good glass is obtained.

440 COMPOSITIONS

At the present time in the technical glass field some 440 compositions are melted commercially and made into thousands of products. Glass as an engineering material can be made in density lighter than cork or almost as heavy as iron; in a wide range of hardness, and in the form of fibers as soft as silk; with controlled transmission and absorption of light in the infrared, visible, ultraviolet, and X-ray regions of the spectrum; in mechanical strength greater than that of cast iron; in resistance to heat shock from yellow heat to ice water. This broad range of physical characteristics possible with glass will be discussed in detail under the five headings: Optical, Chemical, Thermal, Electrical, and Mechanical Properties.

OPTICAL PROPERTIES

In the case of optical properties, we are very familiar with the colored traffic signals so commonly used in all fields of transportation. The red, yellow, and green colors have been very carefully selected for limits and their characteristics measured and recorded by the U. S. Bureau of Standards. However, filter glasses are not limited only to the part of the spectrum that the eye can see, but can be made to absorb or transmit infrared light which is entirely invisible to the human eye. Thus, we may have a black glass which will transmit an appreciable amount of infrared heat rays or, conversely, a colorless glass which will block off or absorb most of the heat energy in the infrared region beyond the visible. The black infrared-transmitting glass may be used in burglar alarm systems or in signaling by invisible light. The other type of glass, which absorbs infrared heat and transmits visible light, is used in combination with incandescent lamps where the heat from the lamp should be screened from the lighted area, as for hospital operating tables. The same type of glass is used for eyeglasses with greatly increased comfort when hot glowing objects must be viewed.

USE WITH ULTRAVIOLET

Similarly, glasses can be made for use with the ultraviolet part of the spectrum, which transmits or absorbs

ultraviolet light but at the same time absorbs or transmits visible light. One such ultraviolet-transmitting glass, which is practically opaque to visible light, is used in airplane instrument panel lighting. Here it is important that the instruments should be easily read with the minimum amount of light so as not to interfere with the pilot's night vision. The instrument markings and pointers are outlined with fluorescent paint which faintly glows under the stimulation of the black ultraviolet light transmitted by the special glass filter. This system of instrument panel lighting is now being used in several popular brands of automobiles.

X RAYS

In the X-ray region of radiation, glasses are made that transmit or absorb X rays. The former type is used in making X-ray tubes and the latter in X-ray-absorbing shields to protect the equipment-operating personnel. Thus, in the field of light transmission, glasses are available with absorbing or transmitting characteristics for various parts of the spectrum of radiation.

CHEMICAL PROPERTIES

Most glasses are hard and chemically durable. In the dry atmosphere of Egypt, glass articles made thousands of years ago have been preserved in the tombs of the Egyptians in excellent condition. However, when it comes to a gage glass for a steam boiler, the service conditions are surprisingly severe. Many glasses subjected to steam and water condensate at 100 pounds pressure will practically disintegrate in the course of 100 hours, whereas others will come through this test almost unaffected. Obviously the latter type must be used for gage glasses while the former may be entirely adequate for less severe service conditions. Similarly glasses differ among themselves in their resistance to corrosion by acids or alkalies.

THERMAL PROPERTIES

In thermal properties, glasses again have a broad range of physical characteristics. Heat-shock resistance, which may be defined as ability to withstand sudden changes in temperature, is controlled to a large degree by the thermal expansion coefficient of the glass, that is to say, the fractional change in dimensions of a piece of glass with change in temperature. Glasses are available with a range of thermal expansions from 5.5 to 128×10^{-7} per degree centigrade, compared with steel having an expansion coefficient of 125×10^{-7} per degree centigrade. In this problem of resistance to heat shock the Vycor brand 96% silica glasses have an extremely low expansion coefficient with a very high melting temperature and yet can be fabricated by practical glass-working methods producing a wide variety of finished products. These are made by a unique process which has been called the only new development in glass making since glass melting began.

SPECIAL PROCESS

A special alkali-borosilicate glass is melted and formed by conventional methods into the desired but oversized shape. Soaking in an acid bath after a controlled heat treatment dissolves out most of the soft fluxes and leaves

a porous structure which is 96% silica in composition. This porous glass is permeated with tiny submicroscopic holes about two tenths of a millionth of an inch in diameter. These holes are extremely numerous, so many that the total surface area of the holes in one ounce of porous glass amounts to about $1\frac{1}{4}$ acres. In this form the glass is a good dehydrating agent, and, handled with moist hands, it feels sticky owing to the rapid absorption of moisture. If the porous glass is heated to a high temperature the holes close up, the glass becomes a clear, impervious body, and the product shrinks by about 14% in all dimensions. This shrinkage can be accomplished with practically no change in shape, so that the final product dimensions can be predetermined. The advantage of this process is that 96% silica-glass products can be made with extreme resistance to heat shock and to chemical corrosion, by conventional glass-melting and forming methods. If this composition were to be melted and formed directly, the manufacturing process would become very difficult and expensive on account of the extremely high temperatures required, well above the melting point of steel.

THERMAL PROPERTY OF GLASSES

Another unusual thermal property of glasses is their ability to transmit heat in spite of the fact that they are classed as heat insulators rather than heat conductors. For example, glass has become the accepted material for oven baking ware, since, by reason of its ability to absorb oven heat, pies and cakes are baked better and more quickly in glass dishes than in bright metal ones. In the chemical-manufacturing field, glass heat exchangers are found to be practical, since the transfer of heat from steam or other sources through the walls of glass tubes into the chemical to be heated depends more on the surface condition of the glass pipes than on the thermal conductivity of the glass itself. Since glass does not easily corrode, such glass heat exchangers may compare favorably in heat-transfer rates with exchangers made of other materials of higher specific conductivity which may corrode or collect a film on the surface, materially reducing their heat-transfer efficiency.

ELECTRICAL PROPERTIES

In the electrical field, glasses are classed as insulators, but again they have a broad range of electrical resistivity, varying according to the glass compositions. The best-resistivity glass has an electrical resistance 100 million times that of the lowest-resistance glass, and there is a wide choice of glasses for different electrical applications. Similarly, for radio and radar use, glasses are available with extremely low power loss, that is to say, only a very slight absorption of energy in the insulating material. One of the new applications in the electrical field is glass-insulated capacitors, which are finding good acceptance for radio and radar equipment. These capacitors are made from "ribbon glass," which can be manufactured in thicknesses as small as 0.001 inch and widths of 2 inches or more. The availability of a good dielectric material for capacitor insulation with characteristics that in some respects are superior to mica makes this an important project in our war effort, since the best mica for this purpose has to be imported.

MECHANICAL PROPERTIES

Glasses are fundamentally strong materials. Strengths as high as 2 million pounds per square inch have been observed in tension tests on glass fibers. The absolute strength of a glass depends markedly on the surface condition of the sample, and so these extremely high strengths are not found in glass products, since their surfaces are usually scuffed or abraded. However, by proper choice of glass, good design, and in some cases added finishing treatments, glass products can be made with excellent mechanical strength. For example, it is possible to split a 2-by-2-inch-wide oak block with a tempered glass wedge driven with a lead hammer. The strength of Pyrex brand tempered glass piping can be demonstrated by using the glass pipe to drive a 4-inch nail into a block of wood. Thirty-four million pieces of tempered glass restaurant ware were supplied to the armed services in World War II on the basis of excellent serviceability and light weight. Glasses are elastic materials having a range of elastic moduli with a ratio of two to one from the highest to the lowest. Many common commercial glasses have an elastic modulus about one-third that of steel. Glass springs could be made for applications where corrosion resistance, such as in contact with acids, is an important problem, keeping the spring design within the limits of the material. Glasses also can be very accurately finished and will maintain this surface accuracy over an indefinite period of time. This is one reason for selecting glass as the material for large telescope mirrors such as the 200-inch disk now in use at Mt. Palomar.

BASIS FOR LINES OF PRODUCTS

These are the characteristics that constitute the basis for the lines of products now being manufactured, such as electric light bulbs, fluorescent lamp tubing, radio bulbs, cooking ware, lighting ware, laboratory and pharmaceutical ware, railroad, marine and aviation signal ware, chemical and food plant piping, tea- and coffee-making ware, Double-Tough tumblers, and gage glasses. Among the important new products that either have been recently developed or are in the process of development at the present time are television bulbs, lighting equipment for fluorescent lamps, decorated opal kitchen ware, vacuum bottle parts, 96% silica-glass products, optical glass, ornaments, Multiform glass, metallized glass, electrically conducting glass, Foamglas, and photosensitive glass.

BRIEF DISCUSSION OF NEW PRODUCTS

Time permits only a brief discussion of a few of these new products. For example, the old established method of making optical glass has been completely transformed. Formerly optical glass was manufactured by a batch process, melting and stirring in a clay pot, cooling under controlled conditions to produce complete fracture of pot and glass content, and selecting an extremely low yield of finished product from the irregularly shaped broken pieces. Then the selected glass was further broken to the approximate weight desired, reheated, and pressed into the correct shape, and this step was followed by annealing, trimming, grinding, and polishing. The new method is much more direct, in that the glass is melted in a continuous process

and formed by high-speed automatic machines into finished blanks which, after annealing, are ready for grinding and polishing. This new method makes a product of better quality at a high efficiency and is being extensively used for making ophthalmic lens blanks and optical parts of other types.

OPTICAL GLASS BLANKS

A modification of this method has been used for making large optical glass blanks for such purposes as wind tunnel windows, and high-quality massive lenses for the new precision aerial cameras. These blanks, ranging from 100 to 1,500 pounds, will compare favorably in quality with any optical glass of similar size obtained from Germany or elsewhere.

FOAMGLAS

Foamglas material is an interesting new form of glass which has only two thirds the density of cork and is made in the form of a sealed cellulated structure which floats in water and does not absorb moisture. For thermal insulation in roofs and refrigerated buildings and as the core material for concrete or other types of construction panels, Foamglas is finding an excellent acceptance in the field. This product is manufactured by an affiliated company, the Pittsburgh Corning Corporation.

E-C GLASS

Electrically conducting glass, or E-C glass as it is called, is only in the pilot plant stage at the present time but has promise of a number of useful applications. Essentially the new electrically conducting materials consist of a good insulating glass as a base with a transparent fired-on electrically conducting coating on the surface. The stable electrical resistivity and other properties of these E-C glasses make them suitable for products operating with electric heat on 115- or 230-volt power supply. This opens up the development of completely new types of electrical products with unusual performance characteristics. For industrial baking and drying operations, domestic space heaters, and other heating applications, E-C glass gives promise of excellent service. Another interesting application for one type of this material is in heat screens in places where workers or operators are exposed to the heat of yellow-hot metal ingots. The E-C glass, which to the eye appears clear with good visible light transmission, reflects a high percentage of the heat radiation from such hot bodies; these windows are finding application for glazing operators' cages in steel mills.

PHOTOSENSITIVE GLASS

Photosensitive glasses constitute a most interesting development in glass composition. At the present time there are three types of photosensitive glass. All of these may be exposed with a suitable negative in contact with the glass by using ultraviolet light such as can be produced with a carbon arc. After exposure the image is developed by bringing the glass to red heat. In the first type of photosensitive glass the developed picture comes in a range of colors from a red to a lilac shade, or in sepia tints. The image is actually in the body of the glass; so it has a three-

dimensional character. This type of glass may be used for reproduction of portraits or other photographs, microphotographic records, or accurate scales. As far as can be seen, the finished reproduction is as indestructible as the glass itself.

WHITE OPAL COLOR

The second type of photosensitive glass, which is exposed and developed in a similar manner, produces a white opal color in the exposed areas. For example, by using a film negative made up of $\frac{1}{8}$ -inch black squares separated by clear lines, a louvered glass sheet can be developed which is suitable for use in controlled lighting. Such louvered glass known as Foto-Lite is an excellent material for controlling the direct light from fluorescent lamps. It can be easily cleaned and maintained and has a pleasing appearance. In combination with colored decorations such as can be made by firing on decalomania patterns, interesting sculptured effects can be obtained, since the pattern obtained by exposure is actually in the body of the glass and therefore three-dimensional in character. Such products may find application in lighting and other decorative ware suitable for home use.

The third type of photosensitive glass which also develops a white opal pattern has the unusual property that the developed opal is rather readily soluble in hydrofluoric acid. Thus, by exposure and development, using a suitable negative, the patterns developed in the glass can be dissolved out, leaving a perforated plate. This type of glass, which is known as Fotoform glass, lends itself to many possible applications where holes are required. One possible application which is now being investigated is in the perforated screen plate required by some of the electronic systems for producing colored television as discussed later.

TELEVISION BULBS

One of the most important developments in recent years has been television bulbs for picture tubes. Originally tubes were round in shape and 7 and 10 inches in diameter. The sales trend moved quickly to larger sizes, 12-, 12.5-, 14-, 15-, 16-, and 20-inch-diameter round tubes and then rectangular shapes of 16, 17, 20, and 21 inches in diagonal length. In combination with the various changes in face dimensions, different funnel angles were used, always with the objective of improving performance and decreasing over-all size with maximum picture diameter. The latest design modification in the 17- and 21-inch rectangular bulbs has been a cylindrical-shaped face plate. This change eliminates to a large degree the objectionable reflections from windows or livingroom lights which were so noticeable in the previous face-plate design which was spherical in contour. These various changes have required extensive and continued development of production equipment and methods. One outstanding development in production methods has been electrical sealing of glass parts by which a face plate is sealed to a funnel to complete a bulb using electric heat in the sealing zone, to produce a better and stronger seal. The second development resulted in a new method of manufacturing funnels for both circular and rectangular bulbs: By this method the funnel and tubular neck are formed integrally in one operation, and the weight

of the formed part is much reduced over that obtained by the conventional glass-pressing method.

The large demand for television created another problem in glass composition. The first bulbs were made of a high-lead glass which satisfied the exacting electrical requirements for the tube. However, at the production rate required, it was soon evident that there would not be sufficient lead available for the television industry plus the requirements for storage batteries, paints, and other lead applications. Corning developed a lead-free glass with equivalent electrical characteristics which has solved the problem as far as raw materials is concerned and at a saving in cost and weight.

A second modification in the bulb glass has been the special gray color tint which is now universally used to make the so-called black picture tube. This gray color in the face-plate produces a picture with improved contrast as the color reduces the damaging effect of daylight or other lighting in the picture.

A comprehensive development program is now in progress to work out a practical method for making and assembling a glass tube for color television, regardless of the color system used. We are actively co-operating with all television manufacturers in their efforts to solve this problem. We believe that sufficient progress has been made to date to say that the glass tube will be as important in color television as it has been in black and white. As pointed out in the discussion of Fotoform glass, this material may be used in making the perforated aperture plate for one of the electronic types of color tubes. It should be entirely feasible to produce a perforated Fotoform plate with 275,000 holes in an area of about 100 square inches. Moreover, by the nature of the exposure method, in preparing such a plate, the holes would be properly aligned so as to radiate from a center where the electron guns would be located. This project is being actively pursued at the present time.

Glass as a new engineering material is a medium of great versatility. Rapid strides have been made in recent years in the development of glasses and manufacturing methods, which have greatly expanded the possibilities of many new applications. How rapidly this progress has been made is emphasized if we consider for a moment a condensed time scale in which, let us assume that, the time period from the earliest known man-made glass to the present day is reduced to a total of fifty years. On this basis the modern glass age began some three months ago, and many of the developments herein discussed have been brought about in the last four weeks. If the experience of the past few years may be regarded as indicative of the future, this engineering material, glass, will continue to find new uses which will materially affect the conditions of our industrial and domestic economy. (*Applause*)

* * *

Chairman Gutman: I am sure this is one of the most fascinating speeches I have ever heard.

I will turn the rostrum over to Dr. McIntyre. (*Applause*)

* * *

G. H. McIntyre: Topics assigned to me for discussion are glass fibers and glass fertilizers. This seems rather strange,

as Ferro Corporation has been principally a manufacturer of porcelain-enamel glasses or "frits," ceramic glaze frits, ceramic colors, clay mixtures, chemicals, paints, and electric-heating elements. Because of ever-widening interest and expansion of production, Ferro has recently signed patent license agreements with Owens-Corning Fiberglas Corporation for the manufacture of glass fibers. A production unit is now under construction at Nashville, Tenn. This will be put into operation on or about March 1, 1952.

In the field of glass fertilizers (I will explain this term in detail later) Ferro's central research staff, with the assistance of some of the botany group at Michigan State College, East Lansing, Mich.; several state agricultural experimental stations; other university groups; and private growers, has completed the first five-year experimental program. As a result, Ferro is now ready to introduce an entirely new agricultural frit to the market. The first production quantities have just been manufactured.

Does this background make me an expert in these two fields? I must assume so, because an "expert" is just an ordinary guy away from home. I will present what information I can and hope that you will have a better understanding of these two new products of the glass industry.

GLASS FIBERS

The glass fiber story is one of tremendous growth through research. Games Slayter, now vice-president in charge of research for Owens-Corning Fiberglas Corporation, should be the one to tell this story. About 1931 in a small laboratory in Columbus, Ohio, Games Slayter, Randall Barnard, Jack Thomas, Ed Fletcher, and a few others began to study better methods of forming glass fibers. They believed that, if fine fibers could be formed continuously, many commercial uses for them could be found. Many major problems needed to be solved before any practical applications could be made.

After two years the researches were transferred to pilot plant stage at the old bottle plant of the Owens-Illinois Glass Company at Newark, Ohio. This pilot plant rapidly grew, and the Owens-Corning Fiberglas Company was the result. Today Games Slayter still heads up, as vice-president, the extensive research program being conducted by the company. Randall Barnard believed in the merits of drawing the fiber by a different technique and left the group to form his own company. He is now president of Glass Fibers, Inc., at Waterville, Ohio.

Jack Thomas is vice-president of Textiles, Ed Fletcher heads up the platinum division, and others of the early group have responsible positions with Owens-Corning and Glass Fibers, Inc. Research in new applications, new methods of drawing, and general improvement of fibers continues on a broad scale at Owens-Corning and at Glass Fibers, Inc.

To grasp the meaning of production figures in terms of pounds to dollars output, a graphic illustration is in order:

Most of the continuous fiber made has been drawn through platinum dies in a small electrically heated furnace for remelting glass marbles. These marbles are first made by melting glass forming raw materials and rolling the molten glass in a marble-forming machine. Before being remelted to form the fiber, they must be inspected care-

fully, and all defective marbles containing "seeds" or bubbles are removed from the process. One marble of $\frac{3}{4}$ -inch diameter will furnish enough glass for 30 to 40 miles of fiber. One marble-melting machine or furnace is known as a "bushing," and one bushing delivers 204 filaments to form a standard textile fiber. Production facilities for textile fibers are generally rated by the number of bushings in operation. One bushing will deliver 375 to 400 pounds of fiber per day. Raw-material handling, glass melting, marble making, storage bushings, and all that goes with such equipment require rather tremendous investment before production can be put on a paying basis.

FERRO'S OWN PLANS

I can best illustrate by Ferro's own plans. For the immediate future Ferro will install 8 bushings in buildings of 24,000 square feet area. This is sufficient size to house the complete operations of a 32-bushing plant which will employ over 200 people. The 8-bushing operation, with glass-making and complete "roving" facilities, will employ 35 people and have a production of 3,000 pounds rovings per day with a total value of \$1,200 per day at an average selling price of 40 cents per pound. This quantity of fiber is equivalent to a single strand $4\frac{1}{2}$ million miles in length or 200 times around the earth at the Equator. This production will require an investment of over \$125,000 in platinum (for the bushings) and a total of over \$600,000 in buildings and equipment. The production can be increased 400% without additional buildings but with the installation of 24 additional "bushings," with a corresponding investment for platinum and machinery.

The 8-bushing plant with a production of 3,000 pounds of rovings per day should barely break even on its earnings over costs. Earnings increase with additional bushings about as shown in Table 1.

The present producers and their volume of production according to best estimates are as follows:

Owens-Corning Fiberglas. This company manufactures about 96,000 pounds of continuous fiber per day. Of this total about 40,000 pounds is for covering wire and cable, 5,000 pounds for paper reinforcement, and 15,000 pounds for plastic reinforcement. The additional 36,000 pounds of daily production is distributed between woven cloth for plastics and draperies and miscellaneous products.

In addition to this production of 96,000 pounds, facilities for an additional 40,000 pounds per day are being installed at Andersen, S. C. Of this, 30,000 pounds will be for plastics and 10,000 pounds for industrial yarns.

Libbey-Owens-Ford. This company has a production of 15,000 pounds per day from a 50-bushing plant at Parkersburg, Va.

TABLE 1

Number of Bushings	Gross Profit, %
8	Even
16	7-8
32	22-24
64	28-30

Gustin-Bacon, Kansas City, Kans. Gustin-Bacon has put a completely new plant into operation. When it is up to 100% of capacity, production will be 27,000 pounds per day.

Glass Fibers, Inc., Waterville, Ohio. This plant has a production capacity of something over 12,000 pounds of fibers per day, much of which is for pipe wrapping and reinforcing for plastics and cloth.

Thus, for 1952, total production of textile fiber will be approximately 200,000 pounds per day or 294 million miles of fiber drawn per day in the United States.

This seems to be an astronomical figure in mileage of fiber, and well you might ask: Is the market soon to become saturated? What is the future of this astounding business?

Let us examine this situation. A year or two ago, molded glass fishing rods were something of a curiosity and sold for a rather high price. Today, you can buy one in most hardware stores for any price from \$6.50 to \$15. In 1950 the consumption of fiber for this use alone amounted to 20,000 pounds per week or 1/70 of the total daily production available in 1952. Surely you must admit that fishing rods are a relatively insignificant item and yet they consume an astonishingly large volume of fiber.

Let us look at the potential market in the refrigerator industry. Experiments have indicated that a successful refrigerator liner can be molded from glass-reinforced plastic. One liner requires 8 pounds of fiber. A medium-sized refrigerator manufacturer can make 1,000 liners a day or would require 8,000 pounds of fiber per day. A washing machine tub would require a similar amount.

Glass-reinforced plastics can compete with expensive steel items such as stainless steel and porcelain-enameled steel. The cost is high, but, as production of resins and fibers becomes more plentiful and cheaper, the market will continue to expand. The present market for drawn fibers is in woven cloth such as electric motor insulation, pipe wrap, fabrics, and as reinforcing in molded products. Considerable cloth is consumed in plastic reinforcing, but rovings or continuous-fiber strands of 60 ends of 204 filaments each are mostly used for this purpose.

Reinforced plastics will be used for hard top for automobiles; automobile trunk doors, instrument panels, washing machines, dishwashers, boats, luggage, furniture, toys, window mannequins, and pipe for chemical use. The list is literally unending and only limited by ones' imagination. The demand continues to exceed by far the total production facilities, both operating and planned. The potential peacetime market appears to be almost inexhaustible.

GLASS FERTILIZER

Glass fertilizers, or glass agricultural frit as we prefer to call it, is also a most fascinating subject. This, I can truly say, is strictly a Ferro project from Ferro's research division.

Let me make it clear that, although this product is in fact a glass, not just any glass will do. It is a very special glass, just as fiber is a special glass in a special form.

Agronomists, botanists, organic chemists, floraculturists,

gardeners, and farmers, both professional and amateur, and medical men have realized for a long time that a serious problem exists in nature relating to the exhaustion of trace elements in the soil. The problem and its solution are not fully understood. Many solutions have been tried, the simplest being the more or less indiscriminate addition of small quantities of soluble inorganic salts to the soil, either in the form of mixtures with standard fertilizers or as mixtures to be added separately to the soil. Neither of these methods is satisfactory. Soluble salts can be leached away rapidly by rain, especially in some soils; they can react with highly calcerious (high-lime) soils, in such a manner that the required elements are not available to the growing plant. High-manganese treatment may be helpful or harmful, depending on local conditions. The problem is receiving much study, and there are many "solutions." We are not claiming that our product will solve the problem, but we can say that much favorable interest has developed among scientists who have had an opportunity to investigate and evaluate our approach. We have often been dismissed on first presentation as just another "trace element" fadist group. Invariably, after our story has been heard about the proposed method of solving the problem we have been received most favorably. Many have said that ours is the most sound approach yet devised.

Trace elements essential to plant growth and to the good health of animals include almost all those known in the periodic system of the elements, but the most common metals and nonmetals needed in appreciable quantities, other than the classic nitrogen, phosphorous, and potash (potassium) present in all heavy commercial fertilizers, are iron, manganese, cobalt, copper, nickel, zinc, chromium, and boron.

At Ferro we have been mixing raw materials containing these elements in various quantities for many years and smelting them along with silica and alumina into literally hundreds of different varieties of glasses with varying properties including low solubility. We conceived the idea that, perhaps, if a glass were made with just the right degree of solubility and acidity or alkalinity, and, if it contained important metals (trace elements) in the correct amount, perhaps the plant would respond; it should absorb the needed elements, regardless of soil condition. If this could be established, a truly important contribution to soil chemistry and plant growth would have been established.

In 1947 a grant for studying this idea was established at Michigan State College, and we began to formulate special glasses and to test them, both at Michigan State and at Ferro Research Laboratories.

Much of the early growing experiments were done under closely controlled and replicated conditions of gravel or "hydroponic" culture. In these tests one essential element was omitted from the nutrient solution except for its presence in the granulated agricultural glass. Many early failures resulted, but a basic composition was found from which the growing plant could absorb the trace element without the glass being soluble in the commonly accepted sense. This is accomplished through a complex mechanism of nature known as *base or ionic exchange*.

Not many soil experiments were conducted until this

TABLE 2

Lb Lots	Price per Hundredweight
100	\$16
200-2,400	15
2,500-9,000	14
10,000 and more	13

past season. Extensive growing tests in soil by many state agricultural experiment stations, universities, and commercial growers have shown a remarkable response for many varieties of plants including potatoes, tomatoes, flowers of many types, berries, and tobacco, to mention a few.

Striking advantages of this product should be its *lasting* qualities, its independence of soil and moisture conditions, and its very great potential as a solution to the iron problem in hydroponics.

Essentially, two products will be put on the market: a coarse material for hydroponics, and a finely powdered material for soil culture. Either can be varied in composition to meet specific local conditions.

The glass fertilizer will be manufactured in continuous glass-making equipment, just as Ferro frits are now manufactured for use in porcelain enameling.

Agricultural frit has a potential market wherever there is a minor element soil deficiency or wherever trace elements are not available to the plant because of peculiar local conditions. Growers must be educated to the advantages of using this revolutionary new product. In 1950 approximately 16 million tons of standard fertilizer were sold in the United States. Expectations are for 18 million tons this year. Approximately 100 pounds of glass trace-element fertilizer will be required per acre of soil treated, which is equivalent to about 100 pounds to one ton of standard fertilizer. Thus, if we are able to secure only 10% of the potential market of 1,800 million pounds, there would be a consumption of 180 million pounds of agricultural frit, or almost twice the amount of Ferro domestic enamel frit production. It is our aim to sell 3 to 5 million pounds in 1952 and to expand rapidly after that. This market potential does not consider the hydroponic field, which could be very appreciable in certain areas—particularly Florida.

Production has already begun: The prices of the present products range as shown in Table 2. All prices are FOB Nashville, Tenn. These prices are competitive and compare favorably with porcelain-enamel frit selling prices.

SUMMARY

Two of the most intriguing new glass products to be introduced to the market are fibers and trace-element agricultural frit. Glass fibers are already well established, and the market appears to be ever expanding. Production is far behind demand, both actually and potentially. Production in 1952 will be of the order of 200,000 pounds per day. Investment costs are high, but the potential returns are good, especially on a large operation of 12,000 pounds a day or more.

Agricultural frit has just reached the commercial stage. Much experimental work remains to be done. It could well be fifty years before all the answers are known, if they

ever are. Large-scale production can be had in equipment already available. Duplicate equipment can be constructed as required. The investment is high but is far from prohibitive. The potential market is tremendous; a method of supplying trace elements to soil and hydroponic culture in a practical manner is available to growers at competitive costs. (*Applause*)

* * *

Chairman Gutman: Thank you, Dr. McIntyre. I enjoyed your presentation, and I know everyone else did.

If you have any questions, gentlemen, you may ask them at this time.

Ralph Bishop: I wonder if either gentleman will tell us what these new manufacturers of fiber glass have to pay to the owners in the way of royalty, and whether the royalty applies to just one line, or whether they can go out and make anything at all.

Dr. McIntyre: These patents were offered to industry after a decision of the Supreme Court of the United States. There are two methods of taking out these patents. You can take out a free license and have access to practically all the patterns that are issued, or you can take out a license and pay a very substantial, and I mean substantial, engineering fee for the engineering services to help put you in production.

After carefully considering this matter for several months and investigating the pros and cons and discussing it at quite some length with the representatives of Owens-Corning Fiberglas, and others, our own company elected to take out a free license, hire some experienced engineers who helped develop some of the process, and have our own technical people see what we could do. That is the reason we are starting out with an 8-bushing plant, so we can cut our own eyeteeth. In the long run, we will be a little money ahead.

Mr. Bishop: What would that royalty be?

Dr. McIntyre: It is not a royalty; it is an engineering fee. It varies according to the amount of service for which you ask. It is very substantial. That is information you would have to get from the people offering engineering service. It is an engineering fee that pays for the know-how for that type of business. We are doing our own engineering and getting a free license. It is available to anyone who wants to do it.

Malcolm J. Wood: Could you explain the use of platinum in this process?

Dr. McIntyre: In remelting this marble to a liquid glass, or in the new process in which the marble stage is skipped, where we proceed directly to drawing the fiber, it is necessary to draw that molten glass under extremely carefully controlled temperature conditions which control the viscosity of the liquid glass. In order to draw continuous fiber of these dimensions, it is necessary for that glass to go through an extremely fine aperture or opening. The only metal that is practical to use to form that spinneret is platinum. That platinum is a heavy little furnace about the size of cigar box. It is heated by various means. There are two different techniques. One is used by Glass Fibers, and one is used by Owens-Corning Fiberglas. However, essentially, it is necessary to heat that little platinum cigar-

box furnace under extremely closely controlled temperature conditions.

Then that glass flows down through the 204 openings in the bottom, and that is put on a spinning drum and drawn at a high rate into a continuous fiber and woven on a wheel until we get this strand which consists of 204 strands.

Incidentally, that is one strand. If we break it, we can see there are millions of ends. We need 60 of those to form this. (*Indicating.*)

We cannot do that unless the opening is a constant size. Platinum is the only commercial metal that is available that can be used, that will stand up under those circumstances. As a matter of fact, Owens-Corning has its own platinum division. They manufacture their own dies or furnaces.

Laurence Ferguson: I should like to know the size of the holes that are put into the platinum and the size of the single strand or element of the glass that comes out.

Dr. McIntyre: I do not know whether I can give you that exactly. It is about 1/60 of the diameter of a single hair in your head. Does that give you some idea?

Mr. Ferguson: It would be about 1/200th?

Dr. McIntyre: The size of the opening is the size of the diameter.

Mr. Ferguson: It is the same?

Dr. McIntyre: Yes.

Mr. Ferguson: It isn't stretched?

Dr. McIntyre: No. It flows through, and then it is drawn out. If you take one single strand, you can hardly see it with the naked eye.

Mr. Ferguson: Is it pushed through under pressure?

Dr. McIntyre: There is a very small amount of pressure.

Arthur Marks: I should like to ask a question about the television tube glass. Is that gray-faced glass now commercially available?

Dr. Shaver: Yes. That is the so-called black tube. This is a 20-inch one (*indicating*). The light from the picture comes through once, but the light from the livingroom lamps must go through before it hits the picture, and, therefore, we get a filtered effect.

If we want more details, we will get reduction of halation. A bright spot on the picture sends light to the eye, and so we get a little bit of the diffusion. That reduces that effect, too.

Mr. Marks: Do I gather that a different kind of glass must be used in a picture tube for colored pictures? Be more specific there.

Dr. Shaver: For the color, we will probably want all the light we can get, and so we will probably use a clear tube.

W. L. Fay: What is the potential of using the glass pipe for natural gas?

Dr. McIntyre: Actually, right now, I do not know of any place where it is actually being used. I know that the pipe manufacturers are very much intrigued by its pipe possibilities. It is expensive. I think its application will be somewhat limited to fields that are rather corrosive—corrosive chemicals, and what not.

How much its immediate market would be, I have no way of knowing. It is something that is being experi-

mented with now, and not really used very much. It is just in the developmental state.

Mr. Fay: Can you use the glass fiber for wrapping pipe?

Dr. McIntyre: This is different. The glass fiber for wrapping pipe is to prevent corrosion from the soil. The steel pipe is wrapped with the glass woven clothlike material, then that is impregnated with heavy tar, and that is lowered into the ground, and it forms a corrosion-resistant covering. The glass cloth is merely a binding to hold corrosion-resistant material in place. This is a pipe made of fiber itself. I do not know what the market will be. It is being investigated. Actually, the molded products so far are somewhat limited because of the lack of sufficient rollings or continuous fiber.

Gordon J. Dugan: Dr. McIntyre, what do you expect your profit margin to be in the frit business, and do you expect to maintain it in the face of competition?

Dr. McIntyre: Agricultural frit or porcelain-enamel frit?

Mr. Dugan: Agricultural frit.

Dr. McIntyre: The profit in the agricultural frit should actually be better than it is in porcelain-enamel frit, because the raw material costs will be a little lower and the manufacturing cost will not be so high. The selling price is in the same range. We should equal the profit margin or do a little better than we do on the porcelain-enamel frit.

What was the latter part of the question?

Mr. Dugan: Do you expect the profit to be maintained? Do you expect that competition is going to force your margin down?

Dr. McIntyre: Undoubtedly, we will have competition; so far it is the only product of its kind that is available. A similar type is being manufactured on the West Coast now. They take ordinary phosphate rock and fuse it in electric furnaces. The idea is to make it somewhat insoluble and yet have it in a form so that the phosphate would be available to the plant. That is limited, in its present market, to the West Coast. It does not supply the trace elements except insofar as they might be actually present. Usually, if they are present, they are not in the right proportion. Up to now, we do not have competition. I anticipate there will be some. As the price goes down, the margin will be less.

I should have said before that we have a pretty good position, we think, and we hope to rely on that to some extent.

Mr. Ferguson: You spoke of profit margins of 8% to 10%, for instance, for fiber plants using 8 bushings. Was that figured on investment and on sales, or before and after taxes?

Dr. McIntyre: That was gross profit after taxes.

Mr. Ferguson: On investment or sales?

Dr. McIntyre: Sales.

Mr. Ferguson: Thank you.

Dr. McIntyre: It was 8%. That is for an 8-bushing plant.

Mr. Ferguson: Thank you.

Edna Thompson: To what extent are glass fibers competitive with materials in the apparel industry?

Dr. McIntyre: I doubt very much if glass fibers will be used very extensively as wearing apparel. They tell a story

about Barbara Stanwyck wanting a glass bathing suit. She found that it wasn't any good because it didn't stretch, it was cold, and so on. I do not think it will be suitable for that use.

They think it can be put to some good use for draperies because the material can be laundered and it will be dry in 8 minutes. No ironing is necessary. It is fireproof. It will probably find extensive use for draperies and tablecloths.

As an insulating material, this type is different. They take the fine fiber and reheat it and blow it and form an extremely fine fiber, many times finer than this (*indicating*). That is very, very light in weight. It has excellent heat-resistant qualities. Its so-called K factor is very high. It won't transmit heat. It is used in linings. It is very warm, very light, and very efficient.

In that form, it will find quite a lot of use in clothing. It is also used in airplanes and automobile roofs. It is known as Aircor.

John Muller: How soon do you expect to get your agricultural frit on the market, and what might the initial tonnage be? How much investment might be required to develop a full market there?

Dr. McIntyre: Just now we are announcing the material to be put on the market. Actually, I do not think anybody in our own company knows exactly how it will be marketed ultimately. I think I am in a position to state that definitely.

Our normal method of selling is to sell to other manufacturers. We are not experienced in the distribution to the ultimate consumer. We have been discussing this problem with several manufacturers of heavy fertilizers. They have shown a considerable degree of interest. I rather anticipate much of our initial distribution will be through other fertilizer distributors or manufacturers. Either it can be mixed at the factory or producing end, or it can be sold to the farmer who can mix it himself if he has mixing equipment. We will distribute through present distributors of fertilizers.

Our sales manager told me the amount we expect to sell. I have it written down, and I want to look for it because I do not want to say anything that is not correct.

This was given to me directly by our sales manager. It is up to him to put it on the market. We merely develop it for him. He said: "It is our aim to sell 3 million to 5 million pounds in 1952 and to expand rapidly after that." (*Laughter*) I am just telling you what he told me.

Chairman Gutman: Our time is running short. We have time for only three more questions.

Mr. Wood: Is there any particular reason why glass is more suitable than any other hard element or compound for agricultural frit?

Dr. McIntyre: I don't know what you mean by "any other hard element."

Mr. Wood: Well, metal or a sand or anything else.

Dr. McIntyre: In order to make a material that contains these various metals required by the growing plant, such as iron and so on, the present practice is simply to use a soluble salt. What we have is a fused compound in which we control the rate of solubility and control the amount

of materials and the basic chain as the iron will be transferred to the roots through a complex method.

In order to do that, we need a glass that provides a means of controlling it. On the West Coast they are taking ordinary phosphate rock and melting it in a furnace. That is a form of glass, but they do not control the properties properly. We do not think it will do the job so well.

F. M. Roberts: Is there any difference between the glass fiber made by the Slayter process and that by the Barnard process?

Dr. McIntyre: There is no difference in the fiber at all. The only difference is the difference in the technique of drawing the fiber. The ultimate fiber is exactly the same. I believe they are even using the same basic glass. The end product is the same.

John McDonald: What type of plastic material seems best suited for reinforcement by glass fiber?

Dr. McIntyre: At the present time, so-called polyesters are best. They are an expensive resin. There is a problem of properly wetting the surface of the fiber with a resin. When somebody produces a wetting agent or chemical that will permit the use of cheaper resins, there will be a big advance in the industry. The more expensive polyesters are the ones being used now.

Mr. Elsner: What led you to choose the Owens-Corning process over the Glass Fiber process?

Dr. McIntyre: Mainly, we chose it because it was one of the better licensing arrangements. Our decision was also based on the fact that we considered that Owens-Corning was a much larger company, they had been in business right from the start, and they were the leaders. We believed that our position would be better if we took our licenses from them. I am not sure that that is an endorsement of one process compared with the other. It was just that we believed that the patent position was more sound in the Owens-Corning group.

Chairman Gutman: We have just time for one more question.

Norman Green: Is the agricultural frit a tailor-made product? Will it vary in accordance with demands, or is it always the same?

Dr. McIntyre: The frit can be varied to suit local conditions. For instance, in Florida, there is a serious magnesium shortage. In Michigan and in surrounding territory, there is a serious iron problem. It is our intent to make one product which will contain all the essential elements. You can call it a shot-gun product if you want to. If the particular element is not necessary to the plant, it does not affect it. The plant will not absorb any more than it needs. It is probably easier to make one product.

If some peculiar local condition demands some variation, it is simple for us to take care of it. We make several hundred varieties of porcelain-enamel frits. The basic formula would be the same. The difference would be the amount of any particular element you might need. It is our intent to start with one product and make a fine one. It can be varied when a particular condition requires it.

Chairman Gutman: Thank you, gentlemen. I am sorry we cannot continue. The meeting is adjourned. (*Applause*)

Evolution of the Office Machine Industry

THURSDAY MORNING, NOVEMBER 8, 1951

LESTER S. MILLER, Laird & Co., presiding.
Chairman Miller: Before we start, in case any of you gentlemen are in the wrong room—I hope not—the subject of this particular forum is the office equipment industry in general. The specific title that the chairman of the program selected has to do with the evolution of the office machine industry.

We have been successful in obtaining two speakers who are representative of the industry and who are going to discuss separate phases of the office machine industry. I should like to make it clear at the outset that, because one gentleman will discuss one facet or an over-all picture of the industry and the other will be somewhat more technical in terms of some of the developments of the industry, that does not mean that one company is laggard or the other company is doing something that the first company is not doing. In other words, this is not a discussion of either the Remington Rand Company or of the Burroughs Adding Machine Company. This is an over-all presentation of the industry problem.

One point I would like to mention in regard to this industry that I think is important and may not be touched on by either speaker is that the ratio of office help to the total number of people employed was 13.3% in March 1950, as against only 4% in 1930.

Our first speaker today is Mr. W. E. Morgan who is at the present time the general sales manager of the Burroughs Adding Machine Company. Mr. Morgan is a graduate of the University of New Mexico. His early business experience included work in the public utilities and department stores. In 1934 he joined the Burroughs Adding Machine Company as a junior salesman in the El Paso, Tex., office. In 1937 he was transferred to the home office in Detroit and became a sales instructor. Later he was placed in charge of adding machine sales promotion. In 1941 he was appointed branch manager and then regional manager. Then he became the assistant sales manager. In 1947 he became the sales manager of the operation and in 1950 the general sales manager of the Burroughs Adding Machine Company.

Mr. W. E. Morgan! (*Applause*)

* * *

W. E. Morgan: Thank you very much, Lester. I think we did a good job of rehearsing that introduction last Friday when I called at your office. (*Laughter*)

It is certainly a pleasure to be here. As you know, we had some snow out in the Midwest. The planes were grounded, and very good evidence of the fact that I spent the night on the train is right on my back here this morning.

Every time I am confronted with one of these manuscript deals, I think about the experience of a friend of mine who was reading a manuscript for the first time. He

had spent a lot of time and had put a lot of himself into this manuscript. In fact, he thought he had done a good job. However, after he finished the talk, there was absolutely no response at all. The speech just fell flat. He let it pass for a few days and finally met a pal of his who was present and had heard him. The pal was willing to be very candid with him and, on being questioned, told him that there were three things wrong with him. In the first place, he had read the speech, and that is an unpardonable sin for any speaker to commit. In the second place, he had read it poorly and, in the third place, what he read wasn't worth reading. (*Laughter*)

I don't see any old pals in the audience, and so I won't have that opportunity to check on this deal. However, I am going to read this because, at the time we were rehearsing the introduction, I was told to have a manuscript here this morning.

There is a lot that anyone could talk about and still be within the subject of the evolution of this industry.

THE INDUSTRY TODAY

The office equipment industry today includes 180 manufacturers, employing 90,000 people, and producing 25 major classes of products. Many of the companies in the industry have an interesting and significant history covering a period of more than fifty years—many of the products have a similar period of history back of them. Obviously, it would be quite a task to reach back over this much time and through as many events as have taken place in this industry and come up with a fair assortment of all the facts and figures that are of greatest significance. An attempt to do this would probably degenerate into a mass of statistics, and I am sure that everyone of you is just as adept at gathering and evaluating statistics as anyone from the sales profession.

In fact, I am quite sure that you are more adept at it. However, I have some booklets here that have been put out by the office equipment manufacturers. They are full of statistics. I put as many as I could in my briefcase, and, if any of you are interested in some of the statistics, these booklets are available. If there are not enough here, I would be very glad to see that any of you that care to have them will get them.

A COUPLE OF QUESTIONS

There are, however, a couple of questions that security analysts might well be asked by prospective investors about any of the various industries in which investment opportunities are available, and even a sketchy knowledge of the industry background might be helpful to you in arriving at answers. One of these questions is something like this: What are the prospects for revolutionary product discoveries or new inventions that would substantially improve profits in the immediate future? The other question would

be: What are the marketing opportunities, both short range and long range, that might be peculiar to this particular industry?

EVOLUTION IN THE INDUSTRY

Let us take a look at just a little of the evolution that has gone on in the office equipment industry and see if we can find anything that would throw a little light on these two questions. First, let us look at one or two of the product releases that have been made in the office machine industry and observe some of the conditions that might be encountered in any new product release.

COMMERCIAL TELLER'S MACHINE

In 1932 we developed a commercial teller's machine for banks. It was an entirely new combination of features and an application that had never been mechanized. After about seven years of fairly intensive and expensive promotion, we had three installations. Then came the draft for World War II. Teller turnover and training became a problem, and the machine started to catch on. We now have well over 10,000 of them installed in 20 countries of the world, and one of our competitors has developed a machine for the same job. There is a very good reason why this machine was slow in catching on. The installation of this machine eliminates the use of a passbook, which is generally agreed by most bankers to be worthless anyhow, and the handling of a transaction between the bank and the bank's customers is affected. Also businessmen are inclined to move slowly in making improvements in procedures or routine that in turn have to be explained and sold to their customers. An interesting sidelight—New York was one of the last of the major cities to have an installation of these machines, and even today, New York, which is considered the financial center of the world, has one of the lowest percentages of mechanized tellers cages of any major city in the United States.

PAY-BY-CHECK PAYROLL

Now let me tell you one on Burroughs—we had sold several million dollars worth of payroll check-writing equipment before we installed a pay-by-check payroll for our factory. There was a feeling on the part of our factory management that employees had a better chance of getting home with their money if they did not have a check to get cashed. It was only after a major change in management that a decision was made to start paying by check, and we installed some of our own equipment on this application. Employee welfare and relations were involved, and the change had to be explained and accepted by employees.

CHANGES AFFECT CUSTOMER AND EMPLOYEE

The majority of changes in the mechanization of the office affect either the customer or the employee. Even those that do not affect these two important groups are almost certain to affect a lot of routines that reach far beyond the walls of the office. No physical operation takes place in modern industry without a piece of paper moving right along with it—guiding, directing, and controlling the physical action. In my opinion these conditions have had as much to do with setting the pace for product change in

the industry as the discoveries and developments made in the research and engineering laboratories.

FOLLOWED A SIMILAR PATTERN

The product evolution of all types of office equipment—including adding machines, accounting machines, typewriters, addressing equipment, and the other modern tools of the office—has followed a similar pattern. Let us take a look at this by examining the evolution of the bank bookkeeping machine. Everyone of you who looks over your bank statement from time to time is familiar with some of the work that is done on this machine.

BANK BOOKKEEPING MACHINE

Within the past two years a new model bank bookkeeping machine was released—a machine with close to 100 improvements over its immediate predecessor. All these improvements were important to the banker and the machine operator—many were developed at their request—but none of them are readily apparent to the casual observer. I refer to such mechanical improvements as making it possible to depress keys with a lighter touch, an improved arrangement of the motor bars that activate machine functions, an improved method for correcting errors, an improved journal device, improved alignment of forms, and many other features of that type. All these are important features; yet they are strictly evolutionary in character. About fifteen years ago, automatic totals were introduced on this same bank bookkeeping machine—the machine printed the new balance automatically, without the necessity for the operator even to depress a key. Yet even this change, probably as important to the bank bookkeeper as the self-starter was to automobile drivers, did not cause any line to form at the right. I hate to admit it, but thousands of banks are still using the manual balance machine—a machine that has been in use for more than fifty years.

Going back further, to 1930, we find that another improvement was made on this same basic machine that was of major importance to bank operating people—the front-feed carriage. As you may know, one principal function of bookkeepers—whether commercial, industrial, or banking—is arranging and recording transactions in alphabetical and chronological sequence—usually called journalizing because it is done on a long sheet called a journal. The other main function of bookkeepers is that of ledger or statement posting—collecting and recording all the transactions dealing with one particular account or customer on individual sheets for each account or customer.

The front-feed carriage made it practical for the bookkeeping machine operator to perform both these functions at one time—journalizing and ledger posting. The journal remains in the machine, which automatically spaces it up at the proper time for each entry. This provides a complete carbon copy of all the information that is posted to ledgers or statements. I am glad to report that very few banks are still using machines without the front-feed carriage.

Going back five more years—to 1925—we find that multiple "accumulators" had been made available on this bank bookkeeping machine. These "accumulators" made it pos-

sible for one operator to "accumulate" several items—the new balance on each individual account, the total amount of checks that were posted to all accounts, the total of deposits, and new balances for proving purposes.

SUBTRACTION AND CREDIT

Then going back almost forty years—to 1913—an improvement was made in this machine that was quite significant—and still is. I refer to subtraction and credit, or "red" balances.

But, even before subtraction was made available, banks used this machine as a bookkeeping machine. It did have a duplex feature that was introduced in 1904—that is, the checks could be added in one register, or accumulator, and deposits in another.

ORIGINAL BURROUGHS MACHINE

The next step in tracing back the evolution of the bank bookkeeping machine takes us back to the original machine that William Seward Burroughs invented over sixty-five years ago. We have seen how machine developments have come—and that they have come for several reasons. The manufacturer pioneered in some of these developments in the hope of widening the market for its products, in showing bankers how they could do their job faster, easier, and more profitably. Other developments came at the request of bankers themselves, pointing up an important need in their work that affected the design and function of the machine, and setting a goal for the engineers and designers. Competition—the need to provide something better, more efficient, or more economical than competing companies were offering—also greatly affected the evolution of the bank bookkeeping machine, and of course, of all office machinery and equipment.

The story of the original invention of the Burroughs machine is full of the romance and ingenuity that has been so typical of the beginnings of all American industry. After much hard work and planning, Burroughs completed his first machine in 1885. Market research of that day determined the ultimate market to be 8,000 machines, for the "banking and counting houses" of the United States. With that quota finished, Burroughs believed the job would be done—the banks would be mechanized.

Even this limited objective proved to be formidable. By 1888, two years after the formation of the company, only two machines were ready.

EARLY HISTORY

In January 1891 the Boyer Manufacturing Company, a small blacksmith shop in St. Louis, was authorized to manufacture 100 machines, and in November 1892 the first fifty machines were delivered to a selling agent. He soon discovered that there were important conditions to the successful merchandising of office machines. The first condition was good service. It was useless to install a machine unless it could be given constant and efficient attention. One of the distributors wrote of those days that he dared not locate a machine farther away from his office than Wall Street because he found it necessary to see every machine at least once every day.

It was quite apparent that the product was not a gen-

eral commodity that anyone could order, but rather it had to be sold by individuals who could devote their entire time to sales and service after the initial sale. That basic requirement has not changed.

The first machine simply printed and added items and then totaled. The bank bookkeeping machine was just one of the outgrowths of this original model—and the growth of the industry since that time has been one of complicating a basic framework by incorporating additional features. The bank bookkeeping machine now has approximately 7,000 parts.

MACHINERY COULD DO BETTER JOB

One of the factors affecting the evolution of the accounting machine was the natural acceptance of the idea that a piece of machinery could make it possible for business, such as banking, to do a better job. Another important factor, without which it would be difficult to understand or appreciate the growth of the office machine industry, is the evolution of American business itself during the past sixty years. I am not going to make any attempt to cover this broad subject, but it would be in order to mention a few things that are pertinent to the office machine industry and that have affected it greatly.

The most dominant characteristic of the last sixty years of American business is growth—individual businesses have grown, and entire industries have grown, at a rate that has been phenomenal. Here are a few examples, selected at random, that are typical.

The J. L. Hudson Company was our largest store in Detroit in 1910 and is our largest department store in Detroit today. In 1910 Hudson's had 300 employees—today it has 11,000.

In 1910 this store got along very well with two general-purpose adding machines that were casual aids to their pen and ink system of accounting. Today over 500 Burroughs machines—many of them highly specialized for a particular job—are employed on payroll, sales audit, cycle billing, purchase and payment, and other clerical applications. I do not know how many machines of other makes, but they have quite a number. It would be interesting to know just what would happen at J. L. Hudson if these machines were suddenly removed—if no machines were available. How many additional office workers would be required to do the work? Where would they come from? Where would they work? And how much would it cost?

PROBLEM OF TIME

And, even if the personnel problem could be solved, there would be the problem of time. How much delay would there be in getting to management the information it must have as a basis for many of its day-to-day decisions?

Then consider an even larger and more complex organization, like Westinghouse, with 38,000 people employed on clerical work alone. What would such an organization do without office machines?

Many similar examples come to mind. Telephone companies have 43 million instruments for which users must be billed; for each bill tax must be calculated and included. Railroads have nearly 2 million freight cars in use, and the location of each must be recorded as it passes from one

road to another. Complicated interline accounts must be kept to show the amount of revenue due to each railroad.

Or take the trucking industry—thirty years ago there were less than a million trucks on the roads and streets of the United States. But that business has grown until today there are approximately 9 million trucks in use, hauling 75% of the Nation's freight and carrying to market 90% of all the food we eat.

EXPERIENCE OF ONE COMPANY

The Norwalk Truck Line Company, just one of the many truck companies, processes 45,000 freight bills every month—over 2½ million bills a year—and wrote 160,000 payroll checks last year for its 2,800 employees. And all this from a company that had only 12 employees in 1923.

USE OF MICROFILM

Another trucking company, Pacific Intermountain Express, uses microfilm to condense the 800,000 bills of lading, the 800,000 freight bills, 50,000 canceled payroll checks, and drivers' logs and correspondence, that accumulate in enormous quantities annually and that must be retained to meet legal record-retention requirements. Without microfilming, a comparatively recent addition to the modern line of tools of the office, we might eventually run out of roofs to cover all the millions of records accumulated by business.

I do not need to go further. It is clear that the small business in which the proprietor personally participated in most transactions had a very simple office problem compared with that of thousands of today's large organizations in which many important decisions are necessarily based on reports and figures.

IMPORTANT EXTERNAL FACTORS

There have been several other important external factors in the evolution of the office machine industry. What was perhaps originally a gadget, which gave a little extra speed and convenience to office routine, has now become a fundamental part of our productive system. Business machines are now office tools, essential to the job. The tools of the office are now parallel in significance to the machines in the plant.

If you want a date to mark the point at which office machines began to move toward this new status, you might take 1913. In that year the income tax was introduced to the United States.

The story is told of one of our men who cashed in on the income tax deal. His procedure was to walk into a business concern with a portfolio under his arm. He would ask the proprietor: "Do you have your income tax return ready?" Of course, not many had them ready before March 15. They would tell him they didn't, and he would turn around and walk out very rapidly. Of course, the prospect always thought he was an income tax collector and was in to check with him. The next morning he would go in with an adding machine and attempt to make a sale, and, of course, in many cases he did.

However, he made a call on the second morning on one prospect that he had given that portfolio treatment to the day before. This prospect had sat up all night trying to

get his income tax together. When he found out he was trying to sell an adding machine, he not only beat him up but threw him out and threw out the adding machine right behind him. (*Laughter*)

Income tax raised the level of the office machine market to something entirely different from what it had been before. For the first time, every dollar and cent of revenue had to be accounted for and that accounting completed by a deadline. Immediately speedy and accurate accounting became immensely more significant.

But the demands became even greater as the years passed, until in the late '30's the flow of paper became an avalanche. In 1937 social security was introduced. And there again from the income tax level social security lifted our market to an entirely different level, much higher than it had ever been before. The resultant payroll deductions made mechanized equipment a requirement for every employer with a payroll of any significance. The keeping of accurate and detailed records was a legal obligation.

WAGE AND HOUR LAWS IN 1940

The enactment of wage and hour laws in 1940 not only increased the computation on payrolls, but also increased the cost of paying the people who were figuring those payrolls. And, in the past ten years, inflation and the social revolution have raised wages for even the lowest type of clerical help, with a significant effect on the office equipment industry. It is a lot more important for an employer to mechanize the work of a clerk who is costing him \$50 a week than that of one who was only costing him \$20 a week.

MULTIPLICATION OF RECORDS

The multiplication of records requires more clerks and, consequently, more office machines. In 1900, 2.54% of the employed population consisted of clerks. In 1940, 10% of employees were doing clerical work, and, in 1950, the ratio had reached 12.6%. As clerical jobs grew in number, labor- and cost-saving equipment obviously became more essential. If 12% of our working population is now doing paper work, we hardly dare think what addition to the clerical force would be needed to replace the machines they operate—if they could be replaced.

In the '20's I think we could say that office machines were keeping up with and were perhaps even ahead of the figuring needs of business. But today many of us in the industry feel that customer requirements have caught up. More automatic operation is needed. Business needs to save personnel and lower costs. The youngsters, just out of high school, who are looking for a job can just about "write their own ticket." And this shortage and cost of clerical help is a very serious worry to top management. At a recent conference of executives and personnel chiefs here in New York it was a major subject of discussion.

In response to this pressure, the office machine manufacturer is redoubling his efforts not only to keep pace with but also to get ahead of business needs once more. Millions of dollars are being spent on research. Burroughs has a research organization engaged in the study of electronics as applied to business accounting. We now have plans to build in the Philadelphia area a \$2 million research labora-

tory. At present our electronic research division is composed of more than 200 scientists and technicians, and with the completion of the new building they will have no less than 40 project laboratories in which to continue their work. Electronic computing devices are proving their worth on scientific and engineering problems, and the possibilities are extremely interesting, but I should say here that we do not expect to be in a position to market revolutionary machines for the ordinary business application in the immediate future. The development of the business machine has been an evolution, and not a revolution. We are studying carefully the science of electronics and its application to accounting problems, and one of our principal concerns is the present high cost of completely electronic devices. Many serious problems remain to be solved. The evolution of these techniques will not be a dominant factor in the industry until solutions are found that will make electronic equipment economical for business generally. For the immediate future I believe that mechanical and electromechanical techniques will be the normal methods used in business calculations and accounting.

PROSPECTS FOR PRODUCT DISCOVERIES

Let us now go back and take a quick look at the two questions that were proposed at the start of this discussion. The first of these: What are the prospects for revolutionary product discoveries or new inventions that would substantially improve profits in the immediate future? The evolution of the industry would indicate that prospects are not very likely for the short range, although promising for the long range. Profits are realized only on equipment after it is actually installed in reasonably large quantities, and systems installations can be quite involved because they usually entail not only the users' office but the users' employees, their customers, and internal routines that are far removed from the office as well. This is quite different from the delivery of consumer durable goods that have only to be set in place for installation to be complete. The research and pioneering into new fields can easily affect profits adversely for the short range. Even pilot installations are pretty expensive. Then, too, don't overlook the fact that the same ground rules on high break-even points, controlled material plans, and taxes that apply to other industries hold for this one as well.

MARKETING OPPORTUNITIES

The other question: What are the marketing opportunities, both short range and long range, that might be peculiar to this particular industry? The history of the industry points to only one answer to this question. One of the clearest characteristics of the American businessman is his determination to expand the size of his individual business and his ability to do something about it. One of the clearest characteristics of Government is the capacity to tax—and everyone agrees that we are going to have all forms of taxes with us as far as we can see into the future. One of the clearest characteristics of our present economy is security—old age, unemployment, pensions, and insurance.

There is a clear and definite trend toward higher and higher wages for clerical workers. As long as all of these characteristics exist, it means a continuous avalanche of

paper work and figures. The cost of this paper work is tremendous, and the cost is increasing. The office equipment industry is busy now and will be busy for years to come helping business keep these costs within reason. (*Applause*)

* * *

Chairman Miller: That was the beginning of this discussion in terms of giving us some idea of the sales background, market outlook, and that type of thing.

We now have Mr. Arthur Draper of the Remington Rand Company, who is going to talk probably a little bit more technically in terms of electronics and some future developments in the industry.

Mr. Draper was born in San Francisco in 1910; he is a graduate of the Sheffield Scientific School of Yale University, class of 1932. From 1932 to 1935 he was with the Philco Laboratories. In 1935 he joined the Navy to become a Naval aviator at Pensacola, Fla. He was on active duty flying until 1940. In 1940 he decided to become an entrepreneur and promoted the Langley Aviation Company in New York. This company built the first completely molded plane. Mr. Draper was the vice-president in charge of engineering.

In 1943 the Langley Company was bought by Remington Rand. Mr. Draper became the director of a Remington Rand subsidiary making radar components and aircraft parts during the war. In 1945 he was sent to the new Remington Rand laboratory at Norwalk, Conn., and became the head of the new production section of the laboratory of advanced research. That is a fancy title.

The operation of the Eckert-Mauchly Division is now his major responsibility, and the Eckert-Mauchly Division is the company responsible for something that I am sure you have heard about, something called UNIVAC, one of the new electronic devices applicable to all sorts of business statistical problems.

Mr. Draper. (*Applause*)

* * *

Arthur F. Draper: From that introduction I guess you gather I am an engineer; consequently, probably a screwball. (*Laughter*)

I am going to read this mainly for the same reason that Mr. Morgan did—that we have to write something, which is a damned nuisance; we are both in about the same place, I guess.

TWO KINDS OF EVOLUTION

Essentially there are two kinds of evolution in the office machine industry. The first was covered by Mr. Morgan of Burroughs, who preceded me, and is a type of evolution that is extremely important to all companies, including Remington Rand. The second is a larger-range evolution and is of primary importance, particularly to Remington Rand. This second form of evolution covers the development of entirely new basic approaches to business problems.

Today business systems can be divided into three main classifications. First, largest, and most important is the hand, or manual, approach. Equipment in this field is

used by all businesses, regardless of size. In addition, many companies do not have the volume or need for speed that requires anything more. Evolution in this classification is mainly in the study of work simplification and does not call for many engineering or technical developments.

MACHINE HANDLING OF BUSINESS PROBLEMS

The second is a large field catering to the first stage of bigger business and is the start of automatic or machine handling of business problems. This classification takes in the keyboard-operated machines with their many work-simplifying attachments and semiautomatic control. Essentially, however, these machines are under complete control of an operator and do only what the operator directs. Evolution in this field has been mainly directed toward speeding up what the operator can accomplish.

AUTOMATIC EQUIPMENT—PUNCHCARD EQUIPMENT

The third classification covers the start of automatic equipment—punch-card equipment. Here, for the first time, we have the machine rather than the operator making decisions. Equipment in this classification is vital to many businesses because of the large volume of work that must be processed or because of the limited time in which results must be obtained. Evolution in this classification has been constant and in some cases highly technical.

These three classifications have also been a matter of evolution brought on by the expansion in size of business and the need for faster results. The dividing lines between them are not well defined. The punch card is not necessarily more efficient than the keyboard accounting machine. In fact, it is probably less efficient in the greater number of businesses. Evolution will continue within all these classifications. No one will supplant the other. Each will be applied where it does the best job.

A FOURTH CLASSIFICATION

The subject I intend to discuss today is the evolution that has caused a fourth classification to come into being. This fourth classification is based on truly automatic universal equipment, unfortunately referred to as a large-scale electronic computer. This development will not eliminate punch cards or the other classifications I have mentioned. It will instead take its logical place where the greatest speed is needed and the largest volume of work must be handled. It will, naturally, supplant punch cards in some of the larger installations, but the primary point is that it will make possible the opening of new fields of analysis, planning, and business controls far beyond what we have been able to accomplish in the past.

This is a natural form of evolution for Remington Rand. Unlike our numerous competitors, we make and sell equipment for all classifications of business. One of our points of greatest strength is that we can supply exactly what fits the individual requirement best. This new field just continues along the normal evolution of business machines and fits in with our long-established policy. At present we are very far ahead in this field, and we will remain so.

To clarify this new classification better, there are two things I would like to explain. So much has been published about big computers, mostly from scientific sources,

that the real situation has seemed somewhat confused. I plan to try to give a brief description of the various computers and what they mean. Second, I will try to give some idea of the uses and problems now being handled by the UNIVAC's—the first and only business computers in this field that have been built.

LARGE-SCALE AUTOMATIC MACHINE

The conception of a large-scale automatic machine is quite new. To understand what it means, it is necessary to have a general idea of the thinking behind this development. Because these computers started as mathematical instruments, they are still cloaked in mathematical terms and for that reason somewhat of a mystery. To confuse the matter further, there have been two simultaneous developments that are now blended into one, resulting in a business rather than a mathematical machine.

UNIVAC

As a side remark here, I think I should mention that most people tend to think mathematical problems are more complicated than business problems. Actually, the reverse is true. We have been able, with the UNIVAC, to make possible the writing of whole new concepts of mathematics. This has been fairly easy. In contrast, the computation that goes into Prudential's premium bills is far more difficult. We have from time to time hired very high-class mathematicians. Invariably they hesitate to work for us because they consider that we are a commercial company and are not too interested in pure mathematics. We agree to allow them to specialize in mathematical problems, and they start work. This lasts for about three months, and then the individual mathematician comes to us of his own volition and asks to be put on commercial problems. He has discovered that they are much harder and present a real challenge to his ability. This naturally lets him in for a lot of good-natured ribbing from the others who have traveled the same route, and he becomes one more of the gang trying to unravel the unnecessary, arbitrary complications of business.

LARGE-SCALE MACHINE COULD BE USEFUL

The first development in this field was the conception that a large-scale machine could be useful. It sounds simple now, but I assure you it was a major step requiring a lot of vision and a great deal of work. Credit for this initial step goes to Dr. Howard Aiken of Harvard University. Dr. Aiken was interested in mathematical computation. He has many problems that require a great number of people to use desk calculators. He could lay out his work and use unskilled operators, but the work was very laborious, consisting of: read a figure, put it into the machine, read another, put that in, read the answer in the machine, and write it down. This figure went to the next operator, who used it again with other figures, making a long series of operations with a great many chances for human errors. What Dr. Aiken did essentially was to connect up into one machine some 78 adding machines and a desk calculator. He was able to control these with a player-piano-type roll of paper and eliminate the human error factor. This machine, the Mark I at Harvard, is still in use.

It does one operation after the other in sequence automatically and for that reason is called a selective-sequence automatic calculator. All the calculators I will discuss today fall under this same basic category. In one sense they follow Dr. Aiken's philosophy.

SLOW, BIG, AND CUMBERSOME

This first machine was slow, big, and cumbersome, but it pointed the way. The second machine was built by Bell Laboratories with telephone relays and was a very noteworthy advance. It was very slow also, but it was the start of the first real thinking in the direction of a complete integral machine. It segregated the various functions and was really one machine rather than an automatic connection of machines. Bell Laboratories also introduced checking into the machine itself, which we now consider essential.

The next machine introduced the second simultaneous development that I mentioned above. Both machines already mentioned were slow. For the type of equipment used, they had reached their speed limit. The next move was the very daring idea of building a selective automatic computer by the use of electronics.

ENIAC

Most people said such a thing was impossible. The need was very great, however, and Dr. John M. Mauchly and Mr. J. Presper Eckert, Jr., then at the Moore School, now of Remington Rand, thought it could be done. This was a fantastically large step to take. The computer they proposed would be over 1,000 times as fast as anything built to date. As you all know, they were successful, and the ENIAC is in use at the Army Proving Ground in Aberdeen, Md. This development was a major revolution, and all the machines of today follow this lead and employ electronics for speed, just as they follow Dr. Aiken's original philosophy.

FEW INVENTIONS START IN U. S.

It is also interesting to note here that few inventions start in the United States. It has been our habit to pick up good ideas abroad, and we do the best job at making them useful. One of the few things I know of that started here is the electronic computer. It is also one of the few things they do not have behind the Iron Curtain.

From here on the situation became a little confused. Harvard built a Mark II. This is notable because it was an advance in philosophy. It had only one arithmetic unit. The rest of the machine was made up of storage units. This is the philosophy of all present machines. ENIAC was actually used in this manner but differed in that the storage units were also usable for arithmetic.

IBM built its SSEC and installed it in New York. This was not an advance in the computer art but was important because it made available to nonmilitary personnel a machine capable of solving complicated problems.

The next computer started another major revolution. Up until this time all these machines had been what we call parallel machines. They were similar to desk calculators in that they had numbers and similar devices like counting wheels, and a number was set in each where it remained

static until it was needed. This required a lot of equipment which made a machine big and costly. To eliminate this objection, Dr. Mauchly and Mr. Eckert initiated another major revolution that has been followed by everyone except those projecting the largest special-purpose computers where superspeeds are needed.

BINAC

This development was the so-called serial computer. This idea differs in that numbers are not stored in static form but are literally kept running around in circles and are caught on the fly when needed. The serial computer uses only a fraction of the equipment required in a parallel machine, but in theory it is slower. Electronic speeds can be rather fast, however, and the serial machine can take advantage of the highest known ranges. For this reason the first serial machine still is rated today as the smallest physically for its capacity as well as the fastest. This machine, the BINAC, was built by Eckert-Mauchly and delivered to Northrop Aircraft in 1949. Strangely enough the BINAC is composed of two complete machines rather than one. This was done to make interval checking fast and complete. Both machines do the same work simultaneously and compare results.

FOLLOWED ONE GENERAL PATTERN

After the BINAC many machines have been built by various different companies, but they have all followed one general pattern. Many of them are excellent machines. To understand the pattern they follow, we must go back to Dr. Aiken's original philosophy. As we remember, he had a great deal of mathematic computation to do. He started with very few figures and ended with a very few figures. It was the work in between that was important. This still holds true in the mathematical field, and all the computers today except one have been built for this field.

THE WELL-KNOWN COMPUTERS

Before getting into business computation, I think it might be of interest to list most of the well-known computers and give you an idea of their relative speeds. I will include in this list the UNIVAC, because it is also capable of doing the mathematical problems for which the others were designed. I will discuss its uses later in more detail. The computers today could well be divided into four main classes. The first class would consist of the Mark I, and the Bell relay machine. For the purpose of reference, we might say that these machines have a capacity of 10 calculators. The second group, or medium speeds would consist of the Mark II at Harvard and the SSEC in New York. These have a capacity in the range of 100 to 200 calculators. The third group contains most of the machines that have been completed up to this time and range from about 1,000 to 10,000 calculator equivalents. These machines in ascending speed are listed approximately as follows: (1) Mark III; (2) Engineering Research Associates, Model 1101; (3) ENIAC, built by Eckert and Mauchly, now at Aberdeen; (4) SEAC, which stands for Standards Eastern automatic computer and was built by Dr. Alexander of the Bureau of Standards (This is an excellent machine and rather unusual in that it was built by a Government agency.

It has been responsible for a great deal of development and is particularly noteworthy for its use of electrostatic memory); (5) UNIVAC, currently in mass production (unlike any other computer); (6) BINAC, also Eckert and Mauchly, now at Northrop Aircraft in California.

The fourth group is of primary interest to engineers and consists of two very large and very high-speed parallel machines that have not been completed as yet. These are in the over-10,000-calculator-equivalent class. They are certainly noteworthy in that they will be the most powerful, mathematically, ever constructed. They are the Whirlwind project at MIT which has built a 4- or 5-digit model, using about 4,000 tubes, and the so-called Johnniac that has been designed at the Institute of Advanced Study in Princeton, N. J. It is expected that the Johnniac will be completed shortly, and various universities plan to make copies of it. A good many projects that I have not mentioned are in process, principally at the universities throughout the United States, but I have confined this list to completed computers, except for the big parallel machines in the fourth group.

UNIVAC AN EXCEPTION

The UNIVAC is really an exception to the over-all list. It marks another major development to the credit of Dr. Mauchly and Mr. Eckert. Scientific and mathematical problems have led the way in all the developments so far, but they have one very important missing factor in that they do not require large volumes of input and output data. Second, they are concerned with numbers only. Business on the other hand requires something quite different. Generally speaking, there is a great deal of input data, and the computer must produce something in usual form.

COULD BE CONSIDERED TWO DEVICES

The UNIVAC, therefore, could almost be considered two devices. Basically there is the machine with its ability to do almost anything but think. Incidentally, such machines are often referred to as "brains," but they really have no intelligence and, I am informed, rate somewhere in the intellectual category of a "flat worm." In addition, attached to the UNIVAC are input and output equipment that allow it to take in and put out the large masses of data needed for business problems. It is also unlike any other computer in that it handles the alphabet as well as numbers, and in a typical problem it will put out directly such things as the premium bills that will be mailed to a customer from an insurance company. UNIVAC is also one of the smaller machines in size and, considering the amount of work, takes up a very small fraction of the space that would be needed for punch-card equipment to do the same job.

HAS BEEN PUT INTO MASS PRODUCTION

The most important difference, to you in particular, between UNIVAC and the other computers, is that UNIVAC has been put into mass production. The first machine was completed and delivered to the Bureau of the Census last March. The second machine is now undergoing tests and is soon to be delivered to the Air Comptroller's Office. This machine is to be dismantled and installed in the

Pentagon in Washington. The third machine has been completely erected and is undergoing tests for the Army Map Service. It also is to be installed in the Pentagon. The fourth machine is completed in production, and erection has started at Philadelphia. It may even be possible that some of the first three machines will be diverted from their current use to another Government agency. The production department is well along to completion of machine no. 5, and purchasing on machine no. 8 is already complete.

HOW THE MACHINE WORKS

Before proceeding to actual applications, I think I might give you some explanation of how the machine works and what it does. Essentially the UNIVAC will perform, in the one machine, every single function that the various types of punch-card equipment are able to perform today. Not only does it perform all the functions, but it is also arranged so that it does many of these things simultaneously. This gives rise to additional speed, but it also leads us into one of the more difficult parts of business systems evolution.

LOTS OF OLD WAYS NOT BEST

If the machine such as the UNIVAC is available, it becomes evident that lots of the old ways of doing things are not the best ways. In most of our applications, therefore, we go back to the beginnings of the problems and work out completely new and more sensible methods of handling them. The UNIVAC, therefore, is causing even more evolution in business than that which will come from its faster speed and ability to handle more work. It is also opening up new fields, particularly in the branch of logistics, which it was impossible to contemplate before its advent.

THE UNIVAC takes its input from magnetic tape. There are two reasons for this: (1) We can get so much more information on magnetic tape, and reduce filing space; (2) we can handle tape much faster than by any other medium known so far. The tape we use on UNIVAC is 1/2 inch wide, and 1/1,000 of an inch thick. One inch of this tape carries approximately 120 digits of information, or, as you can see, 50% more than a punch card. Most punch-card machinery works in the 100 to 200 per minute card range. The UNIVAC can accept or produce tape at the rate of 120 inches per second. This means that the speed of input and output is roughly 100 times that of punch-card equipment. The UNIVAC is also equipped to handle 12 of these tape units at the same time. This shows rather obviously that you can work with larger files, take into account more factors, or just plain handle bigger problems.

FIELD IS LARGE AND VARIED

The field that is being opened by UNIVAC is so large and so varied that I find it extremely confusing to attempt to sum it up in a short time. I have, therefore, picked at random 12 actual problems on which we have worked. I will go through these problems very briefly, tell you what they are, and point out where possible just what the UNIVAC can do to them. This is a sufficiently broad list

so that I think it will give you as true a picture as is possible to get without a great deal of study.

PRUDENTIAL INSURANCE COMPANY

The first problem I should like to take up is that of the Prudential Insurance Company. For sometime we have been studying their work and have actually run some of their problems on UNIVAC no. 2 while it was in its test period. One of Prudential's biggest problems is their so-called premium bills. They must put out monthly something over 1 million bills, 340,000 dividends, and 100,000 commissions. This is a typical problem in that a large input and a large output are involved. Also a great deal of calculation is needed. About half a UNIVAC will handle this premium bill job. It will result in savings to Prudential in plain dollars and cents. It will save millions of clerical decisions and a terrific amount of personnel administration. It will not save Prudential time because it is possible for them to accomplish the job as it exists today. Along with the premium bill job, in order to use up the rest of the machine time, we are also studying Prudential's mortgage loan problem. This is a typical case of rearranging the system, and we expect that in something under a year from now we will be able to program this work properly in the new manner. This is also particularly interesting because at present the mortgage loan work is done in many different offices. With a UNIVAC installation, it will be possible for Prudential to centralize loan accounting with the resultant better control.

BUREAU OF THE CENSUS

The second problem on my list is that of the Bureau of the Census. Here, time is the most important consideration. We find an increase in accuracy with UNIVAC, but this is not of first importance. Census feeds into the computer a set of information for each individual in the United States, and the computer breaks this down into about 550 different population characteristics. After this breakdown and tabulation, all done internally, the machine makes up and prints some 30 different tables. This application is one of very large input, large calculation capacity, and very minor volume of output. This is in direct contrast to Prudential's large volume of output, but shows the versatility of the machine, that it can handle both efficiently. Census is also able by use of the UNIVAC to make other computations simultaneously that they have not been able to make before. This is, we are told, important to the statistical analyst but is something that we are not qualified to judge.

SOCIAL SECURITY ADMINISTRATION

The third problem on my list is that of the Social Security Administration. The first UNIVAC application in Social Security will probably be in the statistical field, and the important asset will be time. Statistical work is now lagging a few years behind, owing primarily to the terrifically large volume of data to be processed. A UNIVAC will mean to them that they will get their statistical analysis months instead of years behind and in effect will have it before the data become obsolete. This statistical job in Social Security is quite similar in some respects to the Census work. Eventually we expect that we will apply

UNIVACs to the accounting work as well. Here, as you all know, the mass of data is fantastic, and the saving in file space brought about by the large volume of data that can be stored on tape will be the main consideration.

FORD MOTOR COMPANY

The fourth job is for the Ford Motor Company. This essentially is a production control job, and time is the basic consideration. We are very familiar with this problem from our own experience in building the UNIVAC. Most organizations of the size of our Philadelphia operation would do all their production control with visual files. UNIVAC, however, has so many small parts that we found it completely impossible to set up a large enough battery of visible files, and the time involved in going through these files was so great that we were unable to keep up with the work. We, therefore, were forced to install a punch-card system, and this is operating very well today. Ford, being much larger, has reached the limitations of punch-card systems and is now looking to the UNIVAC for the next step, to enable them to get the speed they need.

BUREAU OF SHIPS

The next problem is that of the Bureau of Ships. This is essentially the job of figuring the requirements in materials and facilities that would be needed for a proposed shipbuilding schedule. Their work starts with actual bills of material and goes all the way back to production potentialities of the mining industry. As we stand today, Bureau of Ships is physically unable to estimate materials and facility requirements. UNIVAC means to them that they will be able to figure accurately and quickly what is necessary. Here UNIVAC is not replacing any other equipment, but is making possible something that could not otherwise be done.

AIR FORCES STATISTICAL SERVICE

The next problem is somewhat similar. The Air Forces Statistical Service's primary interest, however, is in keeping current records up to date. This, you might say, is also Ford's problem. It is a problem for which UNIVAC is necessary because business and control of records have just grown beyond the point where other methods can handle them.

AVIATION SUPPLY OFFICE OF THE NAVY

The next problem is that of the Aviation Supply Office of the Navy, which is the largest centralized supply operation in the world. Their initial interest in the UNIVAC is again one of stock control. They are interested in knowing what they have on hand and in estimating what they must do in the way of orders. They must also determine what materials to ship from depot to depot and must compute requirements for the future from past usages. Currently their punch-card installation takes three months just to process the reports. This means that no ordering can be done until three months after the information is gathered. With the UNIVAC this time can be reduced to approximately three weeks. Ordering and reporting could be done on a monthly rather than a quarterly basis, with the result that stocks could be lower and shortages would

be less frequent. In addition, a UNIVAC on this job will compute additional information which they are unable to get at present.

TREASURY DEPARTMENT

The fifth problem is that of the Treasury Department and covers their work in check reconciliation and check payments. Time is the important consideration here, and the check job will probably be followed by accounting on bond issues and redemptions. The Treasury Department is another very large input proposition. They handle approximately 270 million checks per year; therefore, they must handle approximately $1\frac{1}{2}$ million checks per day. This is a large volume, even to a UNIVAC, and we expect that the Treasury will be a multi-UNIVAC job. UNIVACs in the Treasury Department will also make possible more centralization.

The sixth problem is A. C. Nielsen Company in Chicago, who now do, a large amount of market survey work. The UNIVAC to Nielsen is a plain dollar-and-cent saving. It will give many quicker results, but these are not so important as the pure savings in money.

AIR WEATHER SERVICE

The seventh problem is that of the Air Weather Service which is purely one of statistical analysis. Air Weather Service has large volumes of data that they would like to analyze. No equipment exists today that can make the analysis they need in a reasonable length of time. This application, of course, is a natural for the UNIVAC with its ability to handle large amounts of input data necessary.

ARMY MAP SERVICE

The eighth problem is that of the Army Map Service. Here the UNIVAC will be used purely for its calculating ability. It may be a surprise for some of you to know that it is very hard for us to determine, for example, exactly where Russia is located, owing to the fact that we cannot run survey lines across the ocean. Our only means of obtaining enough information to reach accurately all points in other countries is to work from celestial sights. For example, we found when we invaded Italy in the last war that our maps were off some 6 miles. This is enough to cause great inconvenience, and I personally know some navigators who landed in the wrong place. Mathematical work in computing celestial observations is very great, and for this reason the Army Map Service ordered a UNIVAC some years ago.

Before going to the last and most far-reaching application, I think I should mention that there are several classified uses in the range of missile control that are also mathematical problems and fall into the same general classification as Army Map Services' work.

AIR COMPTROLLER'S OFFICE

The last application is probably the most far reaching in its effect on our future lives. It is the problem of the Air Comptroller's Office and is the type of thing they expect to do with UNIVAC no. 2. This whole problem comes under the heading of what is now called "logistics." It is a new study that has been made possible only by the

advent of the electronic computer. The Air Comptroller's job essentially is to start with a certain number of air groups, or, as they call it, levels of activity. With this beginning, his staff will then compute on the UNIVAC the amount of supporting man power and facilities they will need to keep this level of activity going. They must also compute all the materials and supplies that will be needed, for both the activity and the support. They must further compute the effect of this on the national economy and what the national economy can support. Where time build-ups are required, they must compute optimum programs, including all the scheduling of plants, training, and the like. To go into logistics and what the computations are going to mean to us in the future would take days of study. This same ability to compute will someday make a great impact on your particular business. How soon this will be worked out is probably a function of the war situation. Currently, it is a field that we have not been able to study.

IMPORTANT DEVELOPMENT OF THE FUTURE

I feel as if I had been trying to cram a great deal of information into too small a space of time. I hope, however, that I have been able to explain a few of the high spots and perhaps make you realize what was behind Remington Rand's analysis of Eckert-Mauchly and why we bought their stock. As part of Remington Rand, the Eckert-Mauchly Division has grown nearly five times in size in the last year and one half. We are making the only business computers on the horizon, and we have concrete applications where they are needed. We plan to continue in this field as in all other classifications, and we fully expect that it will be one of the most important developments of the future. (*Applause*)

* * *

Chairman Miller: After listening to some of the things that UNIVAC can do I had the feeling that possibly we could suggest a tenth application, the people in the security business. I wonder if the machine could take all the input data and come out with an answer as to what the stock market is going to do. (*Laughter*)

We have a few minutes before our 12 o'clock deadline.

Ralph Hansmann (General American Investors Co.): I would like to ask Mr. Draper if he has done any work with transistors and what this might mean to the speed and size of these electronic computers in the future. Will it reduce the cost, and just how will it affect the development?

Mr. Draper: A great deal of work has been done with transistors. A great deal of work is also being done with a magnetic element that you probably have not heard of, and a great many of the computers rely almost entirely now on so-called crystal diodes. The tube is on the way out. Of the different approaches I personally do not think the transistor is so important as the magnetic device, but at this stage of the game nobody has the answer. It is in the right direction. So far it is too expensive; the tube is cheaper. That will change, of course.

Mr. Ewing (Morgan Stanley Co.): I would like to ask Mr. Draper if this UNIVAC is going to put a lot of punch-card machines out of business in the future.

Mr. Draper: No, I don't think it will. It will clip off some of the higher-level uses of the punch card, but it will not put the punch card out of business any more than the punch card has a chance of putting Burroughs machines out of business. (*Laughter*)

Carl S. Wittmer, Jr. (Walston, Hoffman and Goodwin): Mr. Morgan mentioned the effects on the market with the advent of income taxes and then of social security. We all know that the Government is considering—or some people in the Government are—a general sales tax. Have you thought that that would, too, have beneficial effects saleswise?

Mr. Morgan: There is no question but that anything that creates more paper work and a demand for more efficiency helps the market for office machines. Another big factor entering into the picture right now that will affect office machines is the complicated cost requirements and records on these governmental contracts.

Mr. Wittmer: The machine you now have, Mr. Morgan, would be usable?

Mr. Morgan: Yes.

Mr. Wittmer: In other words, it would not necessitate any new development on your part.

Mr. Morgan: No. It would stimulate more market.

Nicholas Crane: I would like to ask Mr. Draper a question. UNIVAC, I believe, is for a highly specialized market, and I understand the cost runs from a quarter of a million dollars to half a million dollars a unit. Do you have anything for the mass market?

Mr. Draper: Yes. The point I was trying to make is that there are varied markets—the hand market, the keyboard market and the punch-card market—and now we get into the bigger one which is the UNIVAC market. Particularly in the punch-card market there is a great deal of electronic development in computers that are part of punch-card systems. They will remain very useful, and the development in this direction is very great at the moment.

You also find the same development taking place, perhaps to a lesser extent, in the keyboard field, and Burroughs has done some excellent work that I may know more about than the sales department at times. (*Laughter*) But development in all the lines, except for the hand application, I might say, is going on, and electronics is coming into the picture more and more. UNIVAC isn't the answer to anything—it is the answer to the broadening of the market and to building it up. We sometimes get accused of promoting some of these Government regulations because it increases our business, but actually we do not like them either.

Chairman Miller: I might add an observation on one of the coming things in the future—there is thinking, I know, on the part of some of the people in the office machine industry that it is not too economic to have duplication in each company, to have its accounting department do its own work, and central accounting in terms of a given industry is also a possibility. So that something like UNIVAC—I do not know whether it will be UNIVAC—might be an answer for a lot of small companies who can get their accounting done on a wholesale basis at a cheaper rate.

D. S. Curtis (Woods-Struthers Co.): There has undoubtedly been a lot of forward buying of the industry's products since Korea. Is that over now, and what is your guess concerning the outlook for total sales over the next six months?

Mr. Morgan: I do not believe it is over. Although there was a slump last year in that forward buying, the gross national produce has been increasing something like 3%. The industry has only been increasing something like 3% over-all. In other words, we have not done the job we should have done from a sales standpoint, in view of the complication of paper work and the increased paper work. We did go way up and then we dropped back, but we still are not up to where we should be, and I would say there is a very good reason to believe that the office equipment sales should continue at a very high level. I see nothing to keep it from doing that.

Edmund A. Mennis (Wellington Fund): I want to ask Mr. Draper a question. You mentioned the four fields—the hand operation, the keyboard operation, the punch card, and then the UNIVAC or the electronic computers. I wonder if you could give us some idea of the comparative importance in terms of sales and profits of these various fields. I know that the computers are very romantic, but are they not relatively unimportant in this respect?

Chairman Miller: I think that question is slightly unfair in that Mr. Draper is not connected with the finance of the thing. He can answer it if he wishes, but his discussion was more on the technical phases of the UNIVAC rather than on the profit possibilities of Remington Rand.

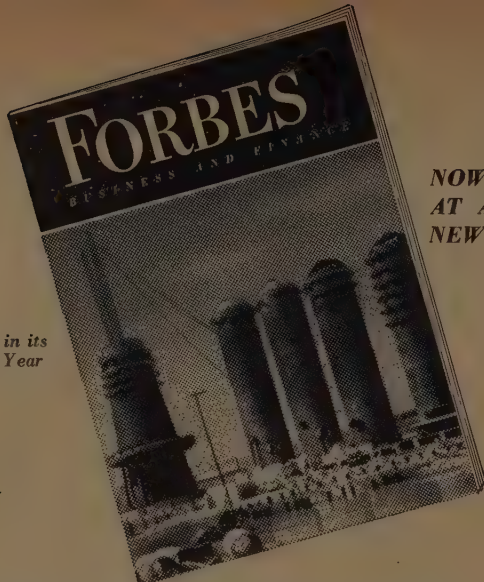
Mr. Draper: I think you probably will have the answer if you will take the number of companies in the business. There is really only one company that covers them all, which is Remington Rand. The rest are pretty well segregated into their own groups, so, if you eliminate Remington Rand from the picture, you would get your breakdown.

I suspect that the largest dollar volume is in the hand-operated stuff. Punch cards do not appeal to all businesses and never will hit the corner grocery store which is the big mass market. But that does not mean that dollar volume in punch cards is not a pretty nice business.

David B. Ingram (Tucker, Anthony and Co.): Mr. Draper, could you tell us just a little more about this magnetic element you mentioned?

Mr. Draper: A lot of that work has been done at MIT and a great deal by private companies. It is possible to take a piece of magnetic material and either turn it on or turn it off by having it magnetized or demagnetized. That is essentially what you are doing in a computer with the tube, you are turning it one way or the other, and, if you put a piece of magnetic material in and wrap a coil around it, you can magnetize it or demagnetize it with that coil, and with another coil you can read it and tell whether it is on or off. There is very little to get out of order, and hence it has some rather nice potentialities.

Chairman Miller: In view of the fact that it is a little bit after 12—unless somebody has an urgent question—we thank both these gentlemen for their kindness in coming here and thank you gentlemen for attending. (*Applause*)



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Outlook for Business and the Stock Market

THURSDAY LUNCHEON, NOVEMBER 8, 1951

SAMUEL B. JONES, Fire Association of Philadelphia, presiding.

Chairman Jones: I think it is better for us to compete against the dessert course rather than delay the schedule, since we have a rather limited time period. While the service continues, if you will bear with me, I will start the ball rolling.

You may have noticed from your program that your luncheon chairman is Sam Jones. I am he. (*Laughter*) Lest your recollection associates me exclusively with the financial analysts in Philadelphia, I want to say right here and now that I am a fully paid up member in good standing of the New York Society, too. (*Applause*)

For the purpose of this occasion, then, if you will assume that my shoes are shined and my hair brushed and that I am wearing a stiff collar, I qualify as your chairman. That being the case, and since I am the first to face this assembled multitude of distinguished analysts, it becomes my great pleasure to greet you all. Be it said that the New York Society of Security Analysts extends an enthusiastic welcome to its members and guests, and particularly to visiting members from out of town, sister Societies in the National Federation, an enthusiastic welcome to this, the Eastern Regional Conference for the fall of 1951.

Our numbers provide adequate proof of our interest, and I think you will agree that our program provides adequate justification of that interest. Although our precise timetable permits no margin for testimonials, I think I should say that somebody—somebody in the form of capable, efficient New York Society leaders, New York Society officers—has presented a splendid program—splendid, that is, up until my advent, but nevertheless holding forth great promise not merely for the remainder of the luncheon, but for the rest of the day.

So much for preliminaries. As the confusion of dessert subsides, we will proceed with our program. Our luncheon discussions to follow continue the mystical art of inquiry into the future which has dramatized previous convention luncheons. Our topic: "The Outlook for Business and the Stock Market." We did have just an hour; I do not know that that still remains. We have three speakers. Each speaker has agreed to limit his crystal ball gazing to 15 minutes. I doubt if there will be time for questions from the floor when we are finished.

You are all well acquainted with our speakers. In fairness to them I should correct any misplaced emphasis I have placed on the crystal ball, for, of course, each of them is well qualified to go far beyond a crystal ball analysis in forecasting our future economic environment. Our first speaker, Dr. George, has had an active part in various Washington enterprises, including the NRA and the WPB. Subsequently, he has continued in close touch with various policy makers and organizations conducting research into our economic affairs. He is a former president of the

Trade and Industry Law Institute, a member of the economic policy committee of the U. S. Chamber of Commerce, and consultant to the National Security Resources Board. We know him best, however, as the economist for Dun & Bradstreet.

It is my pleasure to introduce Dr. Edwin B. George, economist, as our first speaker. (*Applause*)

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Edwin B. George: Thank you very much, Mr. Jones.

Just in the improbable event that there are some among you who cannot bear the suspense of waiting for the conclusion of a forecast, despite the fact that probably every man in the room is qualified to make his own, I will violate tradition today and give you the substance of my thinking at the outset.

SIZE OF MILITARY PROGRAM UNCERTAIN

Despite expected large strides in military production during the next eight months, there is little in the supply-demand prospect itself to force significant further inflation. Developments beyond that point are still blurred by uncertainties regarding the eventual size of the military program, the will of Moscow, and public reaction to both. It is not likely, however, that new contracts under any expanded plans would hit the production lines within the present fiscal year.

INDEPENDENT DEVELOPMENTS

Despite the prospect of a fair balance in supply and demand through mid-1952 under present programs, prices could still be lifted by independent developments. New wage increases would probably project themselves into higher prices in the now familiar pattern. Either public awareness of a projected increase in arms or new international alarms could provide a nervous stimulus to both business and consumer demand. What can be said with reasonable assurance is that these conjectural matters will have to take place before the threat of further inflation should be regarded as serious. Indeed, a combination of events can at least be imagined that would soften our will for security and our longer-term business prospects with it. That might happen if the pressure from abroad for American economic and military aid came to be regarded by the Congress as unreasonable, the economy move at home reached tidal proportions, and the Kremlin peace campaign, true or false, finally made connection with our own deep-seated desires for relief from taxes and controls. But this contingency is also ruled as an action determinative of short-term prospects. And under either assumption profits will drag somewhat behind business volume because of their inherent handicap of rising taxes and costs.

The course of business during the past year was determined primarily by the ballyhooing of crisis, the slower than expected development of military plans, the sensation-

al rise in inventories, and the subdued mental state of consumers after their two pathological outbursts last fall and winter. Those outbursts left a good many people either broke or satisfied and treated us subsequently to a spectacle that we had almost forgotten: namely, a nearly 10% personal saving ratio.

NEXT EIGHT MONTHS PEACEFUL

In contrast with recent performances and barring new international developments that would galvanize us all over again, the next eight months on the economic front should be almost peaceful. The business log should at the end of that period read about as follows:

Outlays for security, broadly defined, continue to lag a little behind schedule, averaging around \$62 billion annual rate during the second quarter of 1952. Federal nondefense spending was only slightly dented by highly publicized attacks as far as goods and services were concerned, and the efforts of states and municipalities to fill genuine needs were largely frustrated by materials shortages and occasional difficulties with credit rationing. Combined nondefense spending by all governments fell off slightly.

Private construction other than housing followed a mixed course. The net effect was that of a gentle but persistent decline, with industrial building bucking the trend until toward the middle of the year.

Producers' equipment and residential construction described opposite arcs, from the second quarter of 1951 through the second quarter of 1952. Sales of equipment rose through the third quarter of 1951 (we may be at the peak right now) and declined thereafter to slightly below the starting point.

On the other hand, residential building continued through the first quarter of 1952 the decline that began in the third quarter of 1950, owing to a few little credit and financing difficulties, interspersed with signs of market saturation at prevailing prices here and there, but rallied slightly in the spring in delayed response to Congressional concern over the course matters were taking and the consequent relaxation of credit terms. One never dares underestimate Congressional compassion in anything connected with housing.

Inventories gave up last summer's attempt at skywriting—although momentum kept the rate of accumulation unusually high, even during the early summer of 1951—and settled down to a slow rate of growth during the next three quarters.

That is the end of the log.

IDEA IS A LITTLE STARTLING

This last idea is still a little startling for those whose main concern these past months has been over the height of inventories and who believe that the economy is highly vulnerable until these are reduced. Stocks of consumer durables probably will come down as advertised, although the drift may be slowed by the combined resistance of a rising spendable income, price control (making some goods unnaturally cheap in relation to incomes), and the recent relaxation of credit terms. (Incidentally, net installment debt showed increases in both August and September.) But, after a few false starts, it seems quite possible, again as disposable consumer income rises, for distributors of soft goods to become reconciled to their burdens and carry on without much ultimate change. In the meantime it is reasonable to suppose that manufacturers' inventories on balance will rise in support of the upward course of defense output. Most of the 1951 increase at this level was

in purchased materials and goods in process on defense orders, and these are thus still pretty good currency. Nevertheless, this forecast of net growth is not intended to obscure the fact that the void left by the disappearance of our genuine 1951 inventory boom will accommodate much of the expected increase in military output and is therefore relatively deflationary.

SPECULATIVE ELEMENT

One of the most speculative elements in the situation is the mood of consumers over the period ahead. They will probably have more money to play with, because the new taxes will not equal the new additions to income, the toughness of the Federal Reserve Board has been reproved by Congress, and, as a result, credit will be easier, taxes will be lighter than had been previously expected or at least proposed, and, if people should decide that they have done enough penance for their buying spree last winter, they could put quite a lot of pressure on supplies. The need to liquidate the heavy installment commitments of 1950 and 1951 will, of course, be embarrassing for some.

SUPPLIES SHOULD RISE

Supplies themselves should rise. But, barring extreme emergency, there is no reason to expect anything remarkable in this respect. Normal additions to the labor force plus some marginal recruits attracted by the high wages or spurred by conscience will considerably outnumber those called to the colors. The work week may be extended a speck. The net course of productivity should be upward but perhaps barely so. Fuller use of capacity than in the past six months—notably in some of the soft goods industries—will show up statistically in a higher rate of man-hour output. Unprecedented additions to plant and equipment over the past five years can hardly avoid adding something also to operating efficiency. In a period of defense buildup, many workers will also be shifting from manual to mechanized operations. Even so, recruits to the labor force will frequently be inexperienced or inefficient, and people generally have evidently not felt the staging of our crisis to be such as to require them to burn themselves out right now. And, in their capacity as members of blocs, many are still more keenly interested in shifting the distribution of current income than in increasing it by extraordinary amounts. But, on balance, we ought to be able to count on at least a perceptible increase in man-hour output.

TWO RESERVATIONS

It is quite possible to visualize an outcome that would have effective demand rising a little more steeply than prospective supply and the result therefore entitled to be called inflationary. The gap should be small, however, and, as far as the mere statistical weight of the forces at work within the period itself is concerned, the inflationary push might even peter out. There is no escape from two reservations on this score, however. One is that the rate of military output should be rising about that time and a Federal cash balance during fiscal 1952 as a whole should give way to substantial deficits thereafter. The second is that the Congress is showing a disposition to up the military program. Probabilities or aspirations: Air Force, 95 to 140

groups; Army, 24 to 30 divisions; Navy, some supercarriers; atomic energy, another \$5-6 billion authorization. Although such increments would not affect fiscal 1952 directly, they might tend to restore a boom psychology. Fulfillment could be something of an anticlimax, as indeed it was to a degree this year; the event of importance would be the evidence of intention. In other words, a few strategically placed gentlemen in Washington could again take the play away from market forces.

NEW INTERNATIONAL UPHEAVALS

None of these observations makes any allowance for new upheavals in the international field, nor new apprehension about them, nor, on the other hand, for the softening effects if the Russian Bear should suddenly start to purr—none of which is a matter of analysis. Also, the evident intention of the unions to keep pressing for higher wages could exert a flanking pressure on the indexes which could push prices above the various levels suggested by simple supply-demand relationships. (*Applause*)

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Chairman Jones: Thank you, Dr. George.

Now if you will set aside your notes of the first speech we will move on to our second speaker, Ragnar D. Naess. He is well qualified by experience and training to continue our discussion. On various occasions he too has served in an advisory capacity to Treasury and other Washington officials. His past connections with Goldman Sachs and Tri-Continental as well as his present affiliation with his own firm of Naess, Thomas and Thielbar give him the investor point of view. As a great sportsman, skier, and sailor he also adds to his perspective.

It is your turn now, Mr. Naess. (*Applause*)

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Ragnar D. Naess: Mr. Jones and fellow members: I think I can say in honesty that my own point of view coincides to a considerable extent with that of Eddie George. I would like to make a few remarks about business, and then I would like to talk at a little greater length about the stock market.

MAIN FEATURES ARE THREEFOLD

It seems to me that right now the main features of the business outlook are threefold:

1. There is a serious decline in a lot of industries which were overbought earlier this year when the public went on a tremendous buying spree and inventories skyrocketed—industries such as textiles, house furnishings, furniture, paper, a number of industries where today operations are at the low level. Earnings are poor. In the third and fourth quarter earnings will be poor not only because operations are low, but also because taxes were increased.

2. A whole lot of other industries are low simply because the materials are not available. Witness the automobile industry, refrigerators, washing machines, consumer durable goods, hard goods, appliances—way down. Why? Well, one reason is that here, again, there was overbuying. But, I think, even more important, or equally important, the

materials are not available. They are being allocated, and production is being forced down.

3. A whole lot of industries are going ahead as fast as they can with the available materials, those industries that are today directly or indirectly important and dependent upon the defense program, whether it be steel, metals, certain types of equipment, capital goods in general, or industrial construction.

GREATER DIVERGENCE OF EXPERIENCE

Now, what I said simply means that probably we have a greater divergence of experience in our economy today than we have had for a great many years in the past. Furthermore, this is what it signifies to me. As long as we have a high rate of capital information and a sense of large expenditure for plant and equipment, and as long as we have rising defense expenditures, I do not worry about low levels of production in consumer goods, because we cannot have a big depression, a serious business decline. I believe that we have enough plant expansion ahead and enough defense spending ahead to make 1952 a good business year. I think 1952 will be regarded as a favorable year in business.

JUST A MATTER OF TIME

If that is so, and national income keeps up because of these dynamic qualities in capital goods and defense, then it seems to me it is just a matter of time before the industries that are now down flat on their backs will recover. And I rather expect between now and next summer to see a substantial improvement in the soft goods industries that are now way down. I also expect to see an improvement next summer or fall in those industries that now cannot produce because of lack of materials, because I think that by that time materials will be more abundant.

AN IMPROVEMENT OF EARNINGS

So, I would say, if you look at the picture, those industries that have very low earnings in the third quarter will have an improvement of earnings. The fourth quarter is the low point in a whole series of industries. I do not say that next year the earnings will be as good for those companies and industries as they were this year, but the trend will be upward. I think there are some other industries where earnings will continue to be at a high level, although not so high as they were in 1951. So, generally speaking, even allowing for increased taxes, 1952 will be a year of good earnings and good dividends, in my opinion.

SELLING ON A CONSERVATIVE BASIS

The important thing to remember about the stock market—and this has been the important thing for several years in the past—is the fact that even today the stock market is selling on a conservative basis in relation to dividends and in relation to earnings. We all know why; this is nothing new. It has been true for a long time. People fear war, depression, controls, higher taxes, all the terrible things that we are so familiar with. Therefore, people have been unwilling to appraise the high earnings and dividends that we have had for a long time on anything

like an optimistic basis. They have refused to go along and think in optimistic terms.

Well, I certainly feel a lot happier about the stock market under that condition than I do about a stock market that is discounting a very sharp rise in earnings and dividends by selling on a $3\frac{1}{2}\%$ or 4% basis, or whatever it might be. Good common stocks today are still yielding not far from 6% . Therefore, I think that the market even today is in a position of discounting bad news ahead. We can have bad news without having a corresponding effect on the stock market.

GOING TO BE EXTREMELY CONSTRUCTIVE

Over the long run, and looking ahead beyond 1952, and assuming business will go down when we get through with the defense effort, if the stock market keeps in its present frame of mind, it is going to be extremely constructive when we face the readjustments that will come at that time. If we look at the picture for 1952 on this basis, I would think that whatever the market is going to do in the immediate future—and I believe we are in an intermediate readjustment period in the stock market, not the beginning of any bear market, an intermediate reaction which certainly was a natural development and the market is entitled to it—I think after that the stock market is going to go up again.

WILL NOT REACH HIGHER LEVELS

I do not believe that the stock market next year will necessarily reach much higher levels than it did this year. I think we have enough ahead of us in readjustments in business and so forth, so that I wouldn't venture that opinion. On the other hand, I certainly do not consider that we can look forward to a substantial, prolonged decline at this time. I think we are in for an intermediate decline limited to 10% , or whatever it might be. However, I consider, there again, that is less important than the selectivity of the market.

BUSINESS IS VERY SELECTIVE

I said that business is very selective. This is going to be reflected in the stock market. The conditions that make the soft drink industry have so much trouble and the conditions that make the chemical industry have such a wonderful time will continue. It is just as though the soft drink industry were in a different country from the United States, in comparison with the chemical industry. I see no change in this situation for some time ahead. So the selectivity factor is of extreme importance, and, if you buy the right stocks and if you are in the right industry, you will do well, and, if you buy the wrong stocks, you will do badly. That is as simple a statement as I can make. (Laughter) I do not see why the industries that have done well in the last year or two because of conditions that exist in the world in which we live will not continue to do relatively well because there is no change in those conditions. I expect the war in Korea to end, but I still think the defense program will go ahead.

I do not expect a world war. I think we live in a world of no war, no peace, so that the companies and industries that are particularly suited for that kind of a world will

continue to do particularly well. I refer, of course, to the chemicals, the drugs, all these companies that have done so well lately. They are high, sure; they will go down because they were a bit too high. But still, over a period of time it is my opinion that they are the ones that will do well as they have been doing in the past. And, as long as the market as a whole is not too high, in a broad sense of the word, I don't worry. I would just as soon hold those stocks.

Thank you very much. (Applause)

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Chairman Jones: I told you he had a remote perspective that was helpful for investment. I must say that his logic is most encouraging. I shall treasure his reasoning for later use should a note of skepticism appear.

Henry Hazlitt, our concluding speaker, is an economist and author. He has been the financial writer for a number of our newspapers and periodicals including the old *Herald*, the *Sun*, the *Nation*, and the *American Mercury*. Until recently he has been on the editorial staff of the *New York Times*. He has a number of books to his credit and at present is associate editor of *News Week* and writes the column "Business Times."

Mr. Hazlitt, what do you say is in store for us? (Applause)

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Henry Hazlitt: Well, I am in a doubly embarrassing position because, first of all, I have not prepared any prophecy, and, second of all, I do not believe in prophecies. (Laughter)

NUMBER OF FACTORS IS INFINITE

I think perhaps I ought to explain that. The reason I do not believe in prophecies is, first of all, that the number of factors we have to take into consideration is infinite, and no human mind could hold them.

ENDOGENOUS AND EXOGENOUS

It has been the habit and practice of writers on the business cycle to speak of endogenous factors and exogenous factors; they are very fancy names, and they have a certain usefulness. But endogenous factors, as you know, are those factors that are supposed to exist within the business itself, and the others are those that are supposed to come from the outside. From here on out I will call them inside and outside factors. (Laughter)

OUTSIDE FACTORS IMPORTANT

The outside factors are terribly important, because you have to know what all sorts of people are going to do, people who are not in business and have no immediate relation to business. You have to know what Mr. Truman is going to decide, what General Eisenhower is going to decide, what Mr. Stalin is going to decide. You have to know what Mr. Reuther and Mr. Murray and Mr. Green are going to decide. You have to know what thousands of different individuals in key positions are going to decide. You have to know what the factors are or what the factors are likely to be that will produce or avoid war, and you have to know how consumers are going to feel at each pre-

cise moment, and you cannot know these things. So there are an infinite number of factors and the inability to know what weight to attach to each factor.

PROPHECY IN BUSINESS WORLD

And then there is another thing about prophecy which occurs in the business world and does not occur anywhere else. That is to say, it occurs in human affairs but it does not occur outside of them. If an astronomer predicts an eclipse, his prediction neither hurries up nor postpones the eclipse. The eclipse takes place whenever it was destined to take place. His prediction may have been wrong, but the eclipse is on time. *(Laughter)*

PREDICTIONS AFFECT THE FUTURE

Now, that is not so in the business world. Predictions affect what is going to happen. For example, if Mr. Naess had predicted a 20-point rise in the stock market a month from now and all of you had gone out believing it, we might have it before 3 o'clock. *(Laughter)* People's beliefs about the future affect that future. If the Government says there is going to be a great shortage of consumer goods, the immediate result is to make that shortage come because everybody hastens to stock up and hoard. The long-run result may be the opposite. It may stimulate producers to overproduce for a long time.

DISTORT WHAT IS GOING TO HAPPEN

These predictions constantly distort what is going to happen. And finally, even if you could predict the future and even if you could be right, there is no point and no gain in being right if everybody else is right. *(Laughter)* As I say, there is no use in saying that the stock market is going to be up 20 points or a given stock is going to be up 20 points six months from now, because, if you know it and everybody else knows it, when you get back and look at the tape, it is already up 20 points. The only advantage of being right is being right in a minority, being right if you can be it alone or being right first and then letting other people in on it afterward. *(Laughter)*

CAN TALK ABOUT PROBABILITIES

Although we cannot predict any certainties about the future, we can talk about probabilities. That is to say, we can say that such and such factors are terribly important and will have such and such results if they act in isolation. If you make a prediction on probabilities and turn out to be wrong, it does not in the least mean that your predictions were not perfectly all right. For example, if there are nine black marbles in a hat and one white marble, and somebody holds the hat up and you reach into it, a man who knows a little about arithmetic can say that there is only one chance in ten that you will pick the white marble. If you do pick out the white marble, that does not show that anything was wrong with his prediction.

PROBABILITIES BASED ON IGNORANCE

Of course, things based on probabilities are based on ignorance. That is, you say it is one in ten because you do not know the other factors. If you knew an additional factor, it might change the problem of probabilities. For

example, suppose the white marble were perfectly smooth and the black ones rough and that the person who put in his hand knew that. Then the probability of his drawing out a white marble would change considerably. *(Laughter)*

LONG RUN AND SHORT RUN

When you are talking of probabilities, then, it is much easier to talk about long-run results than about short-run results. In other words, it is much easier to guess what conditions are going to be two years from now than two months from now. That is partly because you are more easily found out in two months. *(Laughter)* But it is also because these factors can be better guessed over the long range because major factors work themselves out in long runs when they do not work themselves out so much in short runs.

TWO LONG-RUN FACTORS

I would like to talk of two long-run factors. One is inflation. My conviction is that inflation is still dominant in the present world. I am talking not only of the United States, but also of England, France, almost any country that you can speak about today. The general psychology is inflationary, the general wish is inflationary in spite of the fact that there is a great deal of hypocrisy about it. There is a wish for inflation. There are tremendous political forces in favor of inflation, and I do not see at this time any force strong enough to resist these pro-inflationary forces.

SECONDARY REACTION

Just as in a major bull market you can have a substantial secondary reaction, so in a major bull inflationary market, taking it out of the stock market and taking it into business generally, you can have a secondary reaction. And, if I were to make a series of guesses on the short-run effects, on the results in the next eight months, if I had had a questionnaire in front of me with the same questions that Dr. George answered, I do not think my answers would have been much different from his guesses concerning the short-run results, the next eight months, for example. There was not a great deal of difference between Mr. Naess's expectations and Dr. George's expectations, and I think it is something of a record to have any three speakers on any one program come out with substantially the same set of guesses over a short period. But that seems to be what the situation is, and so it has to be reported. *(Laughter)*

SHORT-RUN GUESSES

Anyway, the short-run guesses would very closely correspond; my own guesses would very closely correspond with the much more informed and detailed estimates of Dr. George. I would have only one thing to add to the remarks that Mr. Naess made about the reasons why the earnings of present companies are not fully reflected or are reflected as they normally are in stock market prices. He gave you a number of very good reasons why this did not occur, but I should like to add one reason, and that is: The earnings of corporations are not so large as they look. They are not so large as the figures say they are. I am not ac-

cusing the accountants of anything but of being in an inflationary situation which distorts the measuring rod as much as it distorts everything else. It is not just a matter of adjusting depreciation charges. That is only one part of the problem. There are so many ways in which inflation distorts apparent earnings as we already have seen—if you want to take a hyperinflation which magnifies everything, you can go back to the German inflation and find that business concerns were earning billions of times as much, literally billions of times as much, as they had been a few years before in terms of marks, but they were going busted just the same.

TO HAVE PERFECT ACCOUNTING

I cannot go into the reasons, but, in order to have perfect accounting, you have to know not only what the past price level was and what the present price level is, but also what the future price level is going to be, and your accounting results depend on your guesses as to what the future price level is going to be eventually. Accounting is not a science. It is a matter of intelligent guesswork, and even intelligent guesswork is thrown out very heavily when you have a completely undependable price level.

I want to go back to inflation. I believe that, if there is any real danger of a deflationary movement and if it reaches to any substantial extent at all, then both parties in Congress will become inflationary in some way or other—I am not trying to guess on precise methods—but, some way or other, more money will get into circulation to restore inflation. That can go on for a long time, and a very good illustration of that is the situation in France.

DEFLATIONARY MOVEMENTS

The franc today has about 1/20 of the purchasing power of the franc of 1938. It has less than 1/100 of the purchasing power of the franc of 1914. But, if you will study the history of the franc over this period, you will find very great and substantial deflationary movements within the upward movement. It is the same sort of thing that any sort of stock market chart would show of these heavy breaks that can be very disastrous to the individual if he is caught in one of them, even though he may be right in his belief that inflation is still dominant.

LONG-RUN TENDENCY IS INFLATIONARY

So, in saying this, I want to do so with the proviso that, although the long-run tendency is inflationary, and although I think we would be very safe in saying that the price level three years from today will be even higher than it is today, we cannot say it with that much confidence about the price level six months from today.

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INTERVENTIONISM AND SOCIALISM

Another major tendency is the continued trend toward interventionism and socialism. I believe that, in spite of the swing of the pendulum in three countries now—Australia, New Zealand, and Britain—away from a declared socialist government, what has happened is that socialism has been discredited and repudiated under that name, but the parties that take over continue to administer the socialism. What happens in effect is this: What the Conservatives said in the last election was that they can administer socialism more efficiently because they do not believe in it. (*Laughter*) They have promised to denationalize only the steel industry, and they are faced with very serious headaches even in doing that. They did not even promise to denationalize coal; on the contrary, they gave their solemn pledge that it would remain nationalized.

CONSERVATIVES CONTINUE LABORITE PROGRAM

So we have a situation in which—and I think we have it already in Chancellor Butler's proposal—what seems to be happening is a continuation by the Conservatives of the Laborite program. To have another cut in imports is no solution at all. It is a part of the collectivized thinking on which socialism is based. So what is happening is that the Conservatives are accepting the premise; they are accepting the kind of reasoning that the Laborites use and are applying exactly the remedy that the Laborites would have had to apply today if their party had been elected.

ONE DIFFERENCE

There is one difference which may have a little hopefulness in it. They did increase the discount rate. They did it very moderately at 2½%, and the *London Economist*, in a very good analysis in its last issue, suggests that the rate ought to be at least 4% if they are really going to halt inflation. I am inclined to agree with that. But there will be every sort of political obstacle to an increase of that sort, and the forces that stand in the way of preserving socialism today and of continuing inflation seem to me unfortunately to be greater and stronger than the forces in the other direction.

Thank you very much. (*Applause*)

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Chairman Jones: Thank you, Mr. Hazlitt.

Now, for the summary of the luncheon speeches, I leave that to you. And, while you are doing that, I want to take occasion to thank our speakers tremendously for a very interesting luncheon period.

The meeting is adjourned. (*Applause*)

Impact of New Technologies on Utilities

THURSDAY AFTERNOON, NOVEMBER 8, 1951

HAROLD H. YOUNG, Eastman Dillon & Co., presiding.
Chairman Young: This is the public utilities forum designated on the program as "Impact of New Technologies on Utilities." As you know, today's program has been built up around the idea of new methods, new procedures, new outlets, cost-saving devices, and other features that will have appeal to the analyst who is interested in some forward-looking industries.

I am sure that some people have been more fascinated by the titles of some of the other forums than by the title of this one, but the fact remains that, at the moment, the utility stocks are coming into the picture somewhat more than they have been in the months immediately gone by, as people begin to realize and appreciate some of the underlying and fundamental advantages of public utility stocks. Some of us who have worked with these stocks over a period of years believe that we are dealing with some very fine merchandise, but it does not always have the glamor that some people in the field would like it to have.

However, I think that our speakers are able to convince you that there is that side of the story to the utility industry because it is a forward-looking industry, and, if the utility industry were not a forward-looking industry, some of these other industries would not be able to do what they are doing today, because the use of electricity and gas is so fundamental in industrial processes of all kinds that, without them, we would not be able to make the progress we are making.

I was asked to provide speakers for this particular forum, and it seemed logical to have representatives of the two most important fields: the electric and the gas. If the period had been a little longer we might have had someone from the telephone company, but, as a presiding officer, I was very eager that our speakers should have the full time they needed without feeling crowded and also a few minutes for questions.

I might specify that the order of the speakers was determined by the people who made up the program, and so this is no recommendation on the part of the chairman of whether you should cook with electricity or with gas. *(Laughter)* I remain strictly neutral on that question today. . . . When I was asked to provide speakers for this particular occasion and for this type of a program, my mind ran to two spots, and in both cases I found wholehearted cooperation with my request. I think, when we talk about technological advancements and programs of new efficiency in the electric field, we immediately think of American Gas & Electric. In connection with the gas business, I knew that the American Gas Association has been the spearhead of a program of research of very significant proportions, and I got in touch with Mr. Wolf, who said that Mr. Cuthrell was the man, by all means, to contact.

I might say that those of us who are in the investment business and working with various companies very quickly

size up the companies who are willing and interested in cooperating with the financial community and those that are not. The willingness of the officials of American Gas & Electric and of the Brooklyn Union Gas Company to come here today and give us time out of their very busy lives is one more example of what I have found over a period of years, that both these companies are most eager to cooperate with the financial community.

Our first speaker will talk about new technologies in the electrical industry. Mr. Graham Claytor is the operating vice-president of the American Gas & Electric Company. His academic background was at Virginia Tech, and he has been with American Gas & Electric or some of its operating subsidiaries over a period of forty-four years. In fact, those have been the only connections in his business career except for a brief period as a student engineer with General Electric.

Mr. Claytor is a Fellow of the American Institute of Electric Engineers. And I might add that on my extreme right we are very pleased to have with us also Mr. Rose, the secretary of American Gas & Electric and its principal financial officer. So at this time I will turn the meeting over to Mr. Graham Claytor. Mr. Claytor! *(Applause)*

* * *

Graham Claytor: Thank you, Mr. Chairman, for that very nice introduction. Ladies and gentlemen of the Society of Security Analysts: When I was asked to talk to you about the impact of new technologies on electrical utilities, I hesitated to accept this invitation to appear before such a distinguished and erudite body. You gentlemen have such a disconcerting way of asking *why!*—especially *why* does such a small percentage of gross income come through to net. Nevertheless, here I am, and, if years of experience in the business is one qualification, I most certainly meet that one, for I have been associated with the AG&E or its affiliates for some forty-four years, having started with Roanoke Traction & Light Company in 1907. The electric business was at that time still an infant industry, even though thirty years had passed since the first commercial electric plant—the Pearl Street Station here in New York—had started operating.

The company that I worked for was owned by a Philadelphia holding company, called the American Railways Company. Our main interest and source of revenue were street railways. We had a side line—a sort of by-product from our traction power plants—which was the sale of electricity, principally for lighting streets and homes.

BUSINESS CONSIDERED FINANCIALLY HAZARDOUS

Now I will tell you younger folks how our business was then regarded by the financial community: Just about the time I chose this profession for my life work, officials of American Railways were offered another holding company called the Electric Company of America. Its holdings con-

sisted entirely of electric light companies. The price was very low, but American Railways turned down the offer. The board of directors of that company was a group of very astute Philadelphia bankers and businessmen. They solemnly inscribed in the minutes their reasons for rejecting the proposal. Briefly, they said that they hesitated to put money into a business that financially was so hazardous. Street railways, with long-term franchises, provided the safest kind of investment, they said, and nothing would ever take their place; besides that, it was a cash business—you put the receipts in the bank every morning, whereas, with this new-fangled electrical business, you had to wait a whole month for your money. True, they would buy a good street railway that had, as I have said, an electric lighting sideline but they didn't like it.

ACQUIRED BY MEN OF BROADER VISION

The amusing or tragic sequel, according to your point of view, was that Electric Company of America was acquired by men of broader vision—perhaps among them were some *security* analysts.

They changed the name of the company to American Gas & Electric Company and rejuvenated it with new financing and new management, and it grew and grew and grew.

In the meanwhile, in spite of the preoccupation of American Railways with the traction business, its electric light and power stepchildren had grown too and—irony of fate—the company that it had spurned bought American Railways in 1924—not because of the street railways which were promptly sold—but to secure certain electric light and power properties that were needed to integrate its system.

EARLIER DEVELOPMENT OF ELECTRICAL BUSINESS

I have told this story as a bit of background to emphasize the earlier development of the electrical business. Of greater interest to you are the developments that have occurred within the past decade. We in the electrical utility industry have every reason to feel proud of the accomplishments of the past ten years. With 30 million customers served in 1940, we had increased the number by nearly 15 million at the end of 1950, or by about 50%. Sales of energy increased 13% in the period, and peak demand went up 109%. To meet this extraordinarily rapid increase in demand, the industry added 28½ million kilowatts of generating capacity and spent over \$13 billion on expanded facilities. This is truly a remarkable record when you consider the average price realized for our product. In 1940 it was 20.6 mills per kilowatt-hour sold, whereas in 1950 it had declined to 18.1 mills per kilowatt-hour. I need not remind you that in the same period the cost of living index had risen 78%.

There are a number of basic reasons for the growth of this amazing industry. Over the years, going hand in hand with the more complete mechanization of the country's manufacturing processes, there has been the realization by industrialists of the advantages of buying central station power rather than producing it themselves. Today, although large industries account for less than ½ of 1% of the electrical utility customers in the United States, they use about one half of all power produced.

Again, residential customers, nation-wide, have doubled their annual consumption in ten years. Representing less than one fourth of the kilowatt-hour sales, they provide utilities with more than one third of their gross revenue.

Now all of this sales expansion has had the effect of reducing the element of fixed charges per unit of energy and, consequently, has helped to offset the constantly increasing cost of doing business. Perhaps even more significant as a balance against rising costs have been the technological advances that have taken place within our industry.

TECHNOLOGICAL PROGRESS

Technological progress has always been a striking characteristic of the electric power industry, an industry that was founded on and came about because of one of the great technological developments of modern times: Edison's invention and development of the incandescent lamp.

SPIRIT OF EDISON

The spirit of Edison's great achievement was maintained in the multitude of improvements that followed the development of central station service in the United States; it continued to be the foundation on which the subsequent structures of a great many utility organizations were erected, developed, and extended. True, there was a short period in the early '30's when the role of technology and the further technical developments of the electrical utility industry was doubted—there were quite a few who were convinced that the only field in which further development was possible for the utility industry was sales—and when ample prevailing opinion held that the industry had reached a relatively stable technological point.

Among these was Dr. Arthur Morgan, formerly chairman of the Tennessee Valley Authority. I heard him say in an address in the mid-'30's that the electrical utility industry had reached a position of stability where little further improvement in the art was to be expected. In contrast, he cited the shoe business as complicated with the more or less constant change in styles contributing to its uncertainties.

Fortunately this idea was short lived, and the past half decade has been particularly notable from the standpoint of technical progress and the basic improvement this has brought about in the economic position of the industry.

Yet, in spite of that well-established tradition some doubt has recently been expressed whether the industry can continue to advance technically and continue to gather the economic strength that it has been able to enjoy heretofore from such technological improvements. There is, to be sure, always reason for questioning the ability of any advance, and particularly a technical advance, to continue after it has had a period of sustained accomplishment. Yet, in the case of the electrical utility industry, it is hard to see any basis for pessimism at this time. There are at least three good reasons for this. In the first place, by tradition and background, the industry has developed a spirit and viewpoint that is the very opposite of lassitude and inertia. Second, growth is still taking place at a very rapid pace, and on most systems the signs of even the beginning of saturation in the growth curve are completely absent.

Consider for a moment the vast possibilities of the heat pump in domestic and commercial applications. As you know, this device takes heat from outdoors on the coldest winter day and uses it to warm an interior. It also can extract heat from both the ground and water. In summer the same equipment draws heat from inside and spills it outdoors. It will transfer up to three times as much heat energy as the electric energy that goes into it. Heat pumps are well past the experimental stage and only await the cost reduction that comes with quantity production to achieve wide acceptance. A heat pump has the potential of increasing the domestic customer's annual use three- to five-fold.

GROWTH IN DEMAND

It is growth in demand that makes possible rapid technical improvements, since, in general, it is economically much less burdensome to bring in improved equipment to supply new demand than it is to improve existing equipment that has become technologically aged. And then there is this factor: Growth itself is enhanced by the improvements that it has helped to bring about. There is thus a feedback arrangement that makes it possible to carry on an operation that is far more extensive than would be possible without it.

ECONOMIC DISTANCE AND TIME

Finally there is a third element: the economic distance and the time that separate the performance of the best units from that of the average. This is particularly significant when it is remembered that the best is not static but is constantly moving forward.

In this connection it is worth while to examine current technological developments. Consider for example the efficiency of producing electricity from coal—and coal is the principal source of power in the United States. One pound of so-called standard coal has within it energy equivalent to 10 million pounds of water falling 1 foot—something to be noted when Government proposes to put many millions of taxpayers' dollars into hydroelectric dams on streams with extreme variations in flow.

Of these 10 million foot-pounds, we are able today to extract in our best plants about 3,600,000 foot-pounds in the form of kilowatt-hours. The average for the steam-generating plants of the Nation is only 2,300,000 foot-pounds per kilowatt-hour, so that, even with known technological improvements, there is still a wide margin for betterment.

When I first went in this business, we were doing well if we got 1 kilowatt-hour out of 4 pounds of coal. By 1925 that had been whittled down to 2 pounds per kilowatt-hour, but the new plants now being built will make a kilowatt-hour from less than 7/10 pound of standard coal.

That reminds me of a story that a friend of mine told me, who had been associated in the early years with Henry L. Dortherty, a great public utility operator in gas, electricity, and oil. He told my friend that he really could not get enthusiastic about the electrical business, particularly generation. He said that you put down the stream in condensing water, you put most of the heat that you got

out of the coal and wasted it down the river. It just did not make sense to him, and, therefore, he much preferred the gas business, where you really got all the heat out of the gas.

To me that is a very interesting statement, because, had he stopped to think: If we are wasting all of this energy, look at the chances for improvement! And, as the opposite of that, take the waterwheel development. The efficiency of the best waterwheels—hydraulic turbines, if you like—forty years ago was just the same as today, around 93% efficiency from a good hydroelectric turbine, and that is what we get today. But forty years ago the efficiency of a steam turbine from coal—you know what the answer is.

The contribution that this one technological improvement has made to lowering the cost of generation, particularly in the face of steeply rising fuel costs, the effect that this in turn has had an expansion of marginal markets, and the influence it has had on improving and stabilizing earnings—all of these are of a major order.

DEVELOPMENT NOT AT AN END

Furthermore, there is no indication that this particular cycle of development is at an end. Not only is there a great deal of work still to be done in raising average performance to a point closer to that of the best, but the best itself has not reached that deadening plateau where the law of diminishing returns precludes further development of trends that have brought about the beneficial results that are evident today.

SIZE OF GENERATING UNITS

Or consider the question of size of generating units. The average size of steam-electrical units ordered and placed in service on the systems of the United States twenty years ago was 25,000 kilowatts. In 1950 the average size was 42,000 kilowatts, and, for units on order, to be delivered in 1951, 1952, and 1953, the average size is 61,000 kilowatts. These are striking changes that technological developments have made possible. They are, however, overshadowed by the immense size of units installed or on order by progressive systems large enough to take advantage of the inherent economies that increased size permits. On our system we have, in operation or nearing completion, seven units, each of which is capable of an output in excess of 150,000 kilowatts, and we have, also under construction, four units, each of which will produce 200,000 kilowatts.

Not only has this growth in size made it possible to keep the capital cost of new capacity down to the point where the increase in unit cost became only a fraction of what would have been expected on the basis of cost indices alone, but also the increased size has brought with it significant economies in operating labor, materials and supplies, and maintenance costs.

All of these cost reductions have made major contributions to the economic soundness of the large-capacity expansion programs which have been carried out on almost all utility systems of the United States. Here, too, although size—particularly of single boiler-powered units—has grown materially, the limits to further development of the

trend are as yet not evident. Certainly units of sizes at least up to 250,000 kilowatts can be clearly visualized and will unquestionably be built and installed over the next ten years.

PHILIP SPORN PLANT

It would give me great pleasure to conduct all of you through our Philip Sporn Plant at Graham Station, W. Va. You would see one of the world's most modern and efficient steam-electric generating plants that a few days ago, with three units in operation, produced 500,000 kilowatts. I would enjoy particularly showing you the control room in that plant as an example of technological excellence. Here is the brain and nerve center of this huge plant. Hundreds of instruments indicate and automatically direct the plant's performance. Here is the height of human ingenuity, providing both automatic and finger-tip control of mighty forces. Dials show instant behavior of equipment, automatic pens write permanent records, lights flash their warnings should trouble develop, while television transmitters permit scanning the seething flame in the distant boiler and close watch on the water level in the steam drum ten stories above.

RISE IN CONSTRUCTION COSTS

Still another phase of utility operations that has been disturbing to management is the steep rise in electric transmission-line construction costs. Here, however, two technological improvements have been going on which have enabled progressive managements to mitigate the effects of the rising indices of construction costs. The first is the series of developments that have made possible the more effective utilization of transmission facilities, so that a given system of conductors and terminal equipment can transmit more kilowatts than was thought possible theretofore. The second is the development of the technology of higher-voltage transmission. Interesting examples of the second development are the new 330,000-volt transmission lines being erected by a number of the subsidiaries of the American Gas & Electric Company System to carry out the function of mass or bulk transmission of power and more complete and effective co-ordination of the much larger and still growing power systems of today, compared with those that prevailed ten or twenty years ago.

In connection with the rapid expansion of both transmission and distribution systems, AG&E has recently purchased and installed in its New York office a most useful tool. Costing nearly a quarter of a million dollars, it makes possible accurate and almost immediate answers to problems that, without it, would take months to solve.

One of a few of its kind in the United States, this network analyzer was purchased for the use of our planning and operating engineers. It will help them in their future plans for the system and in the day-to-day problems involved in keeping the power going where it is needed and in the right amounts.

The analyzer looks like a bunch of instrument panels from our Air Force bombers with a couple of telephone switchboards thrown in. It is a maze of dials and switches, backed up by miles of wiring, tubes, condensers, and other electric devices. It works on the principle that all electric

equipment—generators, transmission lines, circuit breakers, transformers—can be represented in miniature. These circuits on the analyzer act just like their physical counterparts on our present system or any system set up on the "board."

Our engineers can set up, in less than a day, the equivalent of the entire AG&E system—all major power plants, over 7,000 miles of transmission lines, substations, the whole business, stretching from Lake Michigan to the North Carolina border. Once having set up the system, they can solve a variety of problems applying to it—one hour on the board representing weeks of work by skilled engineers. In one room, then, they can determine quickly what size transformer is needed here, the power factor for a transmission line there, what happens when lightning strikes over yonder, or what plants should help carry the load when a 150,000-kilowatt unit goes down for repairs, and a hundred other things that are vital to our service.

Our expansion program, of 1,400,000 kilowatts of additional capacity from 1951 to 1953, represents greatly increased planning and operating problems. We will use this device more and more in our efforts toward providing efficient and economical service to our customers.

From an investor's standpoint, the important effect of all these improvements has been to bring down the increase in the cost of transmitting a kilowatt or kilowatt-hour—which, in the final analysis, is the unit of service—to a small fraction of what might have been expected from an uncritical evaluation of the change in the indices of transmission construction costs. Here, too, there is sound reason for believing that further technological development is possible.

SECOND INDUSTRIAL REVOLUTION

The new or perhaps second industrial revolution which was started in the United States approximately twenty-five years ago has, in general, not been given very wide recognition. This revolution is characterized by machine production, intense technological development, and a much higher rate of production per unit of human effort. It has been accomplished by, and has enormously stimulated, the spreading out of industry beyond the large centers of population. The development of electric power and its universal availability throughout the United States have been an important factor in this revolution. An even more important factor has been the relatively negligible cost of this electric power, which has placed at the beck and call of every worker in industry the mechanical power for lifting and hauling, cutting and chipping, hammering and welding, spinning and weaving, transforming and refining, and for carrying out the myriad operations necessary to produce a greater profusion of goods and services with a smaller amount of labor. This movement, which was so stimulated and aided by electric power, has in turn affected the power industry itself, and has made it possible for the industry to do the job it has done—not only in expanding its service, but also in keeping its costs down and in providing an adequate return for the investor.

There is every indication that the present trend in the United States toward increased mechanization will continue. The trend has been further stimulated by the war in Korea

and by the defense production program. Already the United States makes 42½% of the world's production of electricity, with Russia—its nearest competitor—producing only 9%, which may be one of the factors that have deterred Joe Stalin from changing from a cold to a hot war.

The electrical industry's program calls for increased capacity in 1951 of 7¼ million kilowatts, and 8¾ million kilowatts in 1952, to raise the total installed capacity of plants contributing to the public supply to approximately 84 million kilowatts by the end of 1952—just about double what it was only ten years ago. If that is not enough, more will be forthcoming.

This projected growth, which is the electrical industry's response to foreseeable demands, augurs well for the soundness of investment in well-managed utilities. (*Applause*)

* * *

Chairman Young: Thank you, Mr. Clayton. You certainly did what I was sure you would do in giving us an idea of what lies ahead.

We can allocate about ten minutes for questions and still give Mr. Cuthrell his full half of the program. We are now open for questions.

Edna Thompson (Gerard Trust, Philadelphia): Mr. Clayton, would you say that the electric equipment industry has been at least equally responsible for developments in electrical research with the utility industry, or is there much to choose between one and the other?

Mr. Clayton: I think it has been purely a co-operative effort. I know that, in our company, our engineers work very closely with those of General Electric and Westinghouse, Allis-Chalmers, and all the major companies in both their research and experimental work. I think the same thing is true of the whole utility industry; they all contribute their part to this progress.

Martin Davenport (Nathan W. Levin): You spoke of the development of the heat pump. I think I read the other day that General Electric has just made its first commercial installation. How far away do you think a large-scale development of that is?

Mr. Clayton: When you mention the fact that the General Electric Company just made its first commercial installation—

Mr. Davenport: I may be wrong.

Mr. Clayton: I think you are in that respect. There are a number of commercial heat pump installations; in fact, more than there are in residential use at the present time. For instance, our company has, I think, eight or nine office buildings that are completely heated and air-conditioned with the heat pump. General Electric Company is bringing out a package unit. I think that is probably what you have in mind, and that will be used in residences. Westinghouse is also bringing out one, and Carrier is working on a package unit job.

A number of industries have shown a tremendous amount of interest, and I think the only thing we have got to worry about right now is that the defense program is not going to allow that to be pushed. It has sort of got to take a side seat for a while. Whenever we get mass production of heat pumps we are really going to town.

M. E. Dixon (Merrill Lynch, Pierce, Fenner & Beane): On that heat pump question, I had occasion to see three or four of them in Missouri in homes and I was told they could be good for about 10,000 kilowatt-hours annually in residential use. Does that sound correct?

Mr. Clayton: That's about correct.

Mr. Dixon: Assuming, then, that they get into large-scale production, how fast could you get your generating capacity up to satisfy that production?

Mr. Clayton: All I can say is that the utility industry has always been able to meet the demands as they came along, and I think we will continue to.

Mr. Dixon: That's a terrific output.

Mr. Clayton: That's right, but you must remember that a heat pump installation at the present time costs about \$3,000 for a residence. Well, they are not going to be in demand so fast overnight that we cannot take care of them. I think we will manage them all right.

E. Schneider (Arnold Bernhard): I wonder what reserve margin you are targeting for 1952 or 1953: that is, generating capacity to peak output.

Mr. Clayton: What will our reserve be at the end of 1952 or 1953? We are aiming at 15%. We haven't that now, of course.

Stanford Rothschild (Sun Life Insurance Co. of America): I wonder if any practical work is being done at the present time on the wireless transmission of electric power.

Mr. Clayton: Not that I know of.

Mr. Rothschild: It was being done, I understand, just before World War II.

Mr. Clayton: Not that I know of.

Mr. H. A. Diamant: You referred to the loss of efficiency as the result of the necessity of cooling. Has there been any gain in that respect from the use of higher heat-resistance metals? In other words, is there less loss of efficiency as a result of cooling per kilowatt-hour than there was ten years ago?

Mr. Clayton: I think there has been some increase in the efficiency of condensers as such, but there is still that tremendous loss that does go down the river. Nevertheless, in our heat cycle we have increased our efficiency tremendously, and there is still room for more improvement.

Mr. Lock (Peabody & Co.): Don't you think the poor wiring of the average home is going to limit the increase of power in the home until you have expanded the wiring of homes to take on added loads?

Mr. Clayton: That, of course, has always been a problem with us. In the old days they always wired a house with no. 14 wire and had no additional capacity in the wiring. That has gradually been changed until most houses are now wired with no. 12 wire, which gives you considerably more capacity. And the insulation that is now used in place of rubber—rubber is practically not used any more on house wiring—is a synthetic insulation which can stand much higher temperatures. Where we have conduit wiring, we can get three times as many wires in the new installation as in the old.

But, if you have in mind the wiring as far as the heat pump is concerned—well, that's another story. You have to put that in special just like a water heater.

Mr. Lock: I was just thinking of the wiring in the average apartment house that is very old and very inadequate. Take the homes throughout the country. I wonder if it isn't going to be a real limitation on the increase in use of power.

Mr. Claytor: Well, maybe that will answer the other gentleman. I think we will take care of it.

Charles Tatham (Institutional Utilities Service): Mr. Claytor, in your opinion, what are the possibilities of ultimate remote meter reading to avoid the expense of having meter men call on all the customers?

Mr. Claytor: I do not quite know how to answer that question. All I can say that we have done in that connection is that we have quit reading meters every month. We read them every two months, which has cut our cost considerably. As for remote meter reading with radio or something of that sort, I do not know of any progress that has been made in that respect.

Mr. Tatham: Are you working on it?

Mr. Claytor: We are not, not in our company.

E. H. Tevritz (National Securities and Research): The implications of the further increase in demand would, despite the greater efficiency of coal burning, indicate further coal usage; would it not?

Mr. Claytor: That's right.

Mr. Tevritz: Have you people made any estimates of, say, five years from now, how much more coal might be used by the industry over present amounts, even though the per unit efficiency has gone up?

Mr. Claytor: I do not know that I have any figures on that. For instance, American Gas & Electric at the present time is using 8 million tons of coal a year. If we increase our generating capacity by, we'll say, 10%, I think it is fairly safe to say we will use approximately 10% more coal. It is true that we still are going to operate a lot of plants that are not so efficient as the ones that we now put in, but we cannot afford to scrap them. We won't use quite 10% more, but I think it is safe to assume that the use of coal is going to go up tremendously.

Mr. Tevritz: Is that industry-wide?

Mr. Claytor: That's right.

Mr. Tevritz: And the further increases in most of the power demands are for coal and not for hydro.

Mr. Claytor: That's right.

Chairman Young: Let us have just one more question.

Walter Littlefield (Boston, Mass.): Is there any possibility of using atomic piles in place of coal?

Mr. Claytor: Well, "possibility" is a right large word. I would rather put it on the basis of probability. I do not think there is any probability in the next ten years at least.

Chairman Young: As presiding officer, I think I am charged with the duty of keeping within the time limits, and I would like now to express our thanks to Mr. Claytor for coming up here. He has come away from a busy office and has asked to be excused, which I am sure we will all cheerfully accede in, with many thanks to you for coming here. (Applause)

We have two friends here from Brooklyn Union. On my extreme left, Mr. Griswold, the manager of economic research.

Our speaker this afternoon is Mr. Hugh Cuthrell, the president of Brooklyn Union Gas, making his appearance as the guest of our group. This is one of his early appearances as the president of the company, having filled that post since the 26th of September of this year. However, he has been with Brooklyn Union over a period of twenty-four years.

Mr. Cuthrell is not only a man of standing in his own company and in his own community, but also a man of national standing in the gas industry, as witnessed by the fact that last year he filled the post of president of the American Gas Association, which, of course, is a number one spot in the gas industry.

We are very grateful to you, Mr. Cuthrell, for giving us this time this afternoon, and we will now turn the meeting over to you. Mr. Cuthrell, president of the Brooklyn Union Gas Company! (Applause)

* * *

Hugh H. Cuthrell: Mr. Young, ladies and gentlemen: I am going to follow my text pretty carefully because you are experts and I am not, and, therefore, it seems to me I had better stick to what I have tried to prepare for you as closely as I can.

I would like to say one thing before I get into this. As far as I know, there is keen competition throughout the United States between gas and electricity for the various loads. Generally speaking, however, each of us adheres pretty much to a strict code that we serve the customer in a way that is best and cheapest, and I think that is true almost universally. So, although we have keen competition, it is above board, and our customers know what it is all about, and I have no quarrel with the electric people at all. If our past speaker were serving Brooklyn, I wouldn't worry too much about him taking my cooking load away from me. (Laughter)

I have given considerable thought to the general subject of this meeting: "The Impact of New Technologies on Utilities." I could go into an extensive discussion of many specific technological developments within the industry. However, it seems to me that, to you men of the financial fraternity, it is more important for me to deal with the effect of technological change on the gas industry and its reaction to these changes. It is obvious that significant technical advances directly related to the gas business, such as the development of long-distance, large-diameter natural-gas pipe lines, are having a tremendous effect on the gas industry. It is equally true, though less obvious, that technological changes outside of the industry vitally affect it. A dramatic example occurred early in this century when the electric light almost overnight wiped out gas illumination, which had been the industry's primary business for almost one hundred years.

Consequently, I shall speak to you about the significant activities within the industry which reflect reactions set in motion by the impact of new technologies in its broad sense. To set the stage for this discussion, I would like to take a few minutes to give you some background material about the gas business.

The gas industry is one of the most interesting of the

many great industries of our Nation. It is one of the largest, with total assets of about \$10 billion and serving 25 million customers. It is one of our oldest industries, having operated continuously in the United States since 1816—just one year after the Battle of Waterloo. There are many other superlatives that I could list, but I think that the industry's most impressive characteristic is its historically proven ability to adjust itself to new conditions and participate fully in the dynamic growth of this country.

The gas industry, over its long life, has been dealt a number of staggering blows. It has parried each and moved on to greater heights. The gas industry for most of its long lifetime has been engaged in a fierce competitive battle with the other great fuel industries. As an industry, we have survived and developed because we provided a high-quality fuel service which found acceptance in a free market. Out of our long experience in serving an exacting and ever-changing free society, we have developed in our industry a tough core of realism. We are aware that tomorrow will bring new problems; we are also aware that it will bring new opportunities.

The fact that you have asked to hear the story of the gas industry at this meeting is in itself a dramatic example of the resiliency of the industry. During the period between the start of the great depression and World War II many of you were ready to write off the gas industry as a field for investment. Today you regard us with increasing interest and favor. Obviously the extension of natural gas through long-distance pipe lines to large new market areas has contributed largely to your changed attitude. Actually this is but one factor in the improved earnings position of the gas industry. In the time allotted me I would like to point up some of the significant developments in our industry which have both a short-term and long-term bearing on our ability to make gas company securities increasingly attractive to the investor.

GROWTH OF THE INDUSTRY

From 1933, the low point of the depression, up to the present, the number of gas customers has increased from approximately 15 million to 25 million. This customer growth of about 67% far exceeds the population increase of the last twenty years, which amounted to less than 23%.

For the year ended June 1951, total utility gas sales amounted to over 45 billion therms, compared to 10½ billion therms in 1933. In other words, in less than two decades, the industry has more than quadrupled its sales volume.

Total industry revenues in 1933 were \$680 million. Today, they are around \$2,200 million, or more than three times those of eighteen years ago.

Total assets of the industry today, at about \$10 billion, are about double those in 1937, the first year for which industry data are available.

This growth has been intensive as well as extensive. For example, the consumption per customer has increased over 95%.

All these factors are direct evidence of growth. The industry has translated this growth into improved earnings, as indicated by the increase in net income from approximately \$130 million in 1937 to about \$350 million today.

UNIFIED APPROACH TO COMMON PROBLEMS

I should point out here that composite statistics for the gas industry are indicative rather than conclusive. The industry is composed of a number of diverse segments. There is, for instance, a large difference between a pipe line system and a local distributing company. There are also considerable differences between straight gas companies and the gas departments of combination utilities. But make no mistake; there is a degree of unity of purpose within the gas industry unsurpassed, to my knowledge, by that of any other industry. The focal point of this unified approach is the American Gas Association. Companies serving all but a small fraction of the Nation's gas customers support and actively participate in AGA activities. I have mentioned before that gas utility men are realists, and, as such, we are quite aware that no one of us has all the answers. Industry meetings and AGA committee work provide an effective means for free exchange of ideas.

PAR PROGRAM

As an industry, we are quite aware of the necessity for promoting our business and carrying on technical and economic research to improve operating efficiencies. Each company carries on these endeavors itself, but basic promotion and research can most effectively be performed by group effort. Consequently, after considerable study by responsible industry executives, the PAR program was initiated in 1945. The initials PAR stand for Promotion, Advertising, and Research. This is a true industry program, supported by special contributions by member companies. In addition to \$800,000 from regular company contributions and \$900,000 from special contributions to the AGA laboratories fund, expenditures under the PAR program, now in its seventh year, are currently running at about \$1,700,000 annually. This, mind you, is over and above the promotional, advertising, and research expenditures of individual gas utilities and gas appliance manufacturers. The PAR program has tremendous plus value in two directions. In the first place, it fills gaps in important general promotional and research activities, not economically feasible for individual companies to undertake. Second, it acts as a catalyst which coalesces many diverse, separate plans into a unified whole.

PROMOTION

We, of the gas business, have complete confidence in the value of the fuel service we supply, but we know from long experience that promotion is necessary to maintain a healthy and balanced growth. The graveyard of American business contains many tombstones for enterprises which overestimated the solidity of their position in the markets they once served. The American consumer is fickle, completely unsentimental, and often unrealistic. He will buy a Cadillac where some smaller car would more economically serve his needs. He will buy a particular cooking range because his wife is more interested in how it fits in with the decor of her kitchen than how efficiently it will cook. He will not take the time or expend the effort to find out for himself the relative merits of two products. He prefers to be sold, and he must be resold again and again.

Under the PAR program, meetings are held of gas utility

sales executives to study new techniques of selling. National integrated selling campaigns such as the Old Stove Roundup are initiated. Attractive industry exhibits are arranged for such national shows as the National Home Economics Show, the Master Plumbers' Annual Convention, and the National Restaurant Show. Under PAR direction, the industry has been highly successful in having gas appliances appear incidentally in motion pictures, television shows, and commercial films. Special educational films on gas and gas appliances have been made and are used with schools and civic groups.

ADVERTISING

The advertising phase of PAR is devoted to presenting the industry's story in national magazines and business papers. These media are obviously not feasible for individual companies whose service areas are localized. The national advertising program makes use of all the major magazines and is carefully designed to provide coverage throughout the year. It is co-ordinated with national promotional programs. The PAR expenditures for advertising are now at the rate of approximately \$1 million per year.

RESEARCH

The 1950 PAR report states: "Today's research pays tomorrow's dividends." No truer words were ever spoken. If we look at the gas industry today, it is obvious that a great change is taking place. Natural gas is now available, or soon will be, to all the major consuming centers of the country. Thus, to a large extent, the basic character of the gas business is undergoing a fundamental change. Whereas we have spent a large portion of our existence in producing gas by a highly technical chemical process of upgrading raw materials such as coal and oil, we are now increasingly relying on natural gas, which requires virtually no refining. And yet, in the face of this tremendous change, we in the gas industry are spending increasing time and money on gas production research.

There are two primary reasons behind this apparent inconsistency. As most of you know, long-distance pipe lines are tremendously expensive to build. The answer to successful operation of these projects is a maximum volume delivery of gas. Maximum delivery occurs when the full capacity of a line is utilized day in and day out throughout the year. Unfortunately, the average gas customer does not use gas at an equal rate throughout the year. Consequently, most pipe lines sell gas to distributing companies on a demand-commodity type of rate. Under such a rate, the pipe line contracts to deliver at all times a fixed amount of gas every day during the year. The distributing company is obligated to pay a fixed charge for this commitment, whether or not it actually uses the gas. Under these circumstances, a distributing company could not afford to contract for natural gas up to its peak requirement, which might occur one day a year. The problem is generally met by the distributing company contracting for a lesser amount which it can utilize fairly constantly throughout the year. The excess use above this base load is supplied through a substitute gas produced from its own production facilities. Such facilities are designed for intermittent operation and,

of course, also serve as emergency standby in the event of pipe line supply failures. As the distribution company loads increase, it will be necessary, even with higher deliveries of natural gas, to enlarge the quantities of gas made. It is thus apparent that a definite economic necessity exists for constantly improving the efficiency of the process for making gas.

Much of the research required to realize such efficiencies involves re-examination of basic theories of gas technology. Few individual companies have either the staff or facilities to undertake such studies. The research phase of the PAR program meets the need by contracting projects of this type to qualified research institutions, such as the Institute of Gas Technology, Battelle Memorial Institute, Bureau of Mines, AGA Laboratories, and various qualified universities. To date, more than \$1,500,000 has been expended in the field of research.

Gas production research has already resulted in important technical improvements and has implications beyond the immediate situation. Natural gas supplies are still far in excess of current demands. Based on proven reserves, the supply is more than 25 times the annual national consumption of gas. One acknowledged expert has estimated that, with reasonable expectancy of new gas field discoveries, this ratio may be as high as 70 times annual use. For the last fifty years, geologists have been estimating the ratio of gas reserves to use, and, throughout, the ratio has not varied substantially from around 25 times. The technology of underground geologic analysis has advanced rapidly in recent years. Many qualified men in our industry believe that future discoveries of gas fields will expand known reserves far beyond anything we can presently conceive. It is not unrealistic to imagine natural gas reserves in the United States that will be adequate for the next thousand years.

However, as an industry with a proud tradition of public service, we would be moving contrary to all our instincts if we now rested on our oars under the assumption that natural gas was the final solution to all our problems. With the great advances taking place in all phases of the physical and chemical sciences, it is entirely possible that some day we can produce a substitute gas lower in cost than natural gas. We intend to expand, and we expect to continue in profitable operation, regardless of any changes that may some day occur in the supply and price of natural gas. This is the second and perhaps most important reason for a continuous research program on the technology of gas production.

Under PAR direction, there are many other research projects in progress, dealing with natural gas transmission problems, gas utilization, appliance performance, metering, safety devices, and many other phases of the gas business. Total expenditures for PAR financed research now run about \$600,000 per year.

I should like to mention just a few specific research projects included in the program:

- Carbon-oxygen-steam reactions.
- Catalysts for gaseous reactions.
- Pressure coal gasification.
- Interchangeability of oil gas and natural gas.

Pipe line flow investigation.
Heat transfer in gas space-heating furnaces.
Induction heating in relation to industrial gas heating.
Nitrogen removal from natural gas.

Some mention should be made here of the outstanding work being done by our AGA laboratories. Two laboratories are operated by AGA: the main one in Cleveland and another on the West Coast. The laboratories over the last twenty years have carried out a practical program of appliance testing which has resulted in more efficient and safer gas appliances. The laboratories have established minimum requirements for gas appliances and permit the AGA seal of approval to be affixed to gas equipment that has met these standards after a careful laboratory test. No major appliance manufacturer would think of attempting to sell equipment without the seal of approval. A major portion of the laboratories' research has been in gas utilization, but they have a splendidly trained staff of gas technicians who are capable and who are being used today in other fields of gas research as well.

FUTURE DEVELOPMENTS

An industry that has grown and developed through the vicissitudes of the last 135 years has not reached its present state of financial health and vigor by chance. It has done so by looking ahead and planning for tomorrow. It would be sheer conceit for me to say that we have made no mistakes, but I believe that I can claim for the gas industry a heavy balance on the right side of planning. No business has an easy road to financial success, and the gas business is no exception. We have many problems before us, but we are taking steps to meet them.

NATURAL GAS AVAILABILITY

One of the major problems is how to step up the availability of natural gas at the consuming centers to keep pace with the sharply rising demand for gas.

With the fairly recent development of market areas far distant from major gas fields, it has become increasingly difficult to increase natural gas deliveries at the consuming centers, except at higher cost and heavier capital commitments. Within the industry, we are devoting much effort to minimizing this problem by improving the accuracy of our demand estimates, by increasing the efficiency of existing pipe lines, and finally by developing underground storage at points closer to the market areas. Also we are re-studying the basis of establishing rates for heating service, which is the main contributor to the winter peak supply and cost problem. I cannot prophesy the solution, but I can assure you that, out of our varied approaches, one will be found.

NATURAL GAS RESERVES

I have touched briefly on the subject of natural gas reserves, but I would like to take a few minutes to give you a somewhat more complete picture of the situation. The most recent estimate of the AGA's committee on natural gas reserves, made in December 1950, was that proved reserves amounted to 186 trillion cubic feet. This compares with a production rate last year of approximately 7 trillion

cubic feet. Both are higher today, but the ratio of 27 times reserves to use is not materially changed. Mr. Lyon F. Terry of the Chase Bank estimates that future recoverable natural gas supplies in the United States will exceed 500 trillion cubic feet. Certainly, on the face of it, this is a satisfactory prospect for the gas industry.

The additional gas still to be discovered will cost more. This gas will be found only after extensive exploration. Natural gas was generated by the same geologic circumstances as oil and is generally discovered in the search for the latter. Although fantastic new techniques have been developed for finding new supplies of gas and oil, wildcatting is still a very risky business. And it may be a surprise to you to know that really new fields of gas and oil are generally found by the independent wildcatter rather than by the major oil companies. In 1950, for example, 76% of the rank wildcats (that is, those in unproven areas) were financed and drilled by independents. The average cost of a wildcat is around \$90,000, with 1 chance in 9 of finding sufficient oil or gas to get the money back and 1 chance in 44 of making a large enough strike to make the venture profitable. This is a high risk factor and one that requires and deserves the prospect of high return. Certainly the recent attempt to bring gas production under regulatory control is not in the public interest if it impedes the possibility of new gas discoveries. Regulation of this phase of the gas business by utility return standards would drive away the rugged independent wildcatter who gambles against great odds in hope of winning tremendous stakes. The wildcatter, though he may not realize it, is a most important person, for the gas industry. We applaud his courage, hope for his success, and ask that he be allowed to search for his El Dorado without being tied by regulatory restrictions. We recognize that drilling costs will rise for each year the wells go deeper, but, even though the field cost of gas increases, it is a trend infinitely to be desired over one of a declining rate of new discovery.

ACCELERATED DEMAND FOR GAS

The demand for gas, both in the home and in industry, is rising rapidly. Part of this arises from the startling shift of fuel price relationships since the start of World War II. Since 1935, for example, the retail price of coal has increased about 110%, oil about 118%, and gas slightly over 2%. In many sections of the country, gas is actually lower on a straight fuel cost basis than oil or coal. These latter two are our major competition in the home-heating market. Even before this change in relationships, there was a steady shift to gas house heating; since the war it has become a stampede. It has been difficult to add capacity fast enough to meet this demand. Consequently, many gas companies today are operating under Federal or state restrictions which strictly limit the addition of new heating loads. I want to make it clear that the shortage of natural gas today is the direct result of the shortage of steel arising out of the Nation's defense program.

The gas industry does not expect favored treatment in the allocation of scarce materials, but there are a few pointed observations I should like to make on this subject. A major portion of the gas industry is public utility companies. Such companies are under a statutory obligation to

serve all customers at all times for all types of gas service. Furthermore, such companies operate within a fixed franchise area. Finally, such companies operate with a regulated limit to return on investment. Our home-heating competitors operate without any of these restrictions. With our long utility tradition, it is most repugnant for us to be forced to turn away customers seeking our service. It becomes doubly so when we see oil and coal home-heating equipment installed as a substitute for our service. As a matter of cold fact, less steel, copper, and aluminum are involved in a gas-heating installation than in one of comparable performance using oil or coal. Under this unusual condition, the customer is denied the service he desires; he pays more for his equipment and, in many cases, more for his fuel; he requires more of the metals in critical supply; and the gas company loses a customer which in normal times it would attach. The final touch of irony comes when the supply of coal and oil is temporarily disrupted—as it has been in times past—and the customer turns on all his range burners and huddles with his family in the kitchen while the gas company strives desperately to meet the abnormal peak in gas demand. These are unusual times, and temporary injustices are to be expected; but, if we in the gas industry are to be subject to special restrictions, then, in fairness to our investors, employees, and customers, we believe that competing fuel industries should bear their fair share of the burden. If they do so and restrict equally their new business, perhaps we will get larger quantities of steel, or at least more will be available for defense production.

ECONOMICS OF GAS PRICING

Gas house heating, except for old natural gas areas, has always been sold as a quality fuel at a premium over competitive fuels. Until the comparatively recent change in price relationships, it had been acquired fairly slowly, and at a pace that did not pose difficult capacity problems for the gas company. As a load, house heating is desirable because it is large in volume. It has, on the other hand, the disadvantage of having a low load factor which magnifies a company's peak-day problem. The greatly expanded demand for gas as a home-heating fuel is not entirely due to price. It has been supported in part by an increase in the value of the service. In other words, consumers today are attaching greater value to the benefits of gas heating: that is, cleanliness, constant fuel supply, small space requirements of the equipment, low cost of equipment, gas company service, and so on.

Under the usual regulatory process, a gas utility is limited to a fixed over-all return on its net investment. The effect of this is to produce a rate structure in which the heating rate is often below the value of the service—which means a price lower than a majority of the customers are ready and willing to pay. With huge waiting lists of customers desiring gas heating in many sections of the country, the economics of pricing gas heating is a matter of serious thinking throughout the industry.

To initiate a full and free discussion of this situation, a two-day conference of top gas utility executives was to be held in Chicago at the end of November. At this conference we proposed to let our hair down and search for

some practical method of establishing a price formula for gas heating which would place this very important load on a sounder economic basis. We are prepared to re-examine the fundamental and traditional concept of regulated rates as applied to space heating. It is not likely that in one two-day conference we can find a complete answer. But it is the start of a positive approach in collective action. We shall steadfastly pursue the objective and in time we shall attain it.

I make this assertion with full awareness of the difficult regulatory problems involved.

This may come as a surprise to you, but, as a utility man, I would like to pay a word of tribute to the great majority of utility commissions of this country. For the most part, they are staffed by capable, conscientious, practical men, often serving at grossly inadequate salaries. It has been increasingly evident in recent years that most regulatory bodies fully appreciate that good utility service can only be supplied by a financially sound company. This does not imply that, as a regulated industry, we expect favored treatment; but we are confident that we can work with regulatory bodies in an atmosphere of mutual respect and good faith to the end that action will be taken that is truly in the public interest—and that includes investors and employees as well as consumers.

I have refrained from giving you many statistical data. These are readily available, and I am sure many of you already have them. I particularly recommend to you the annual statistical bulletin prepared by the AGA entitled "Gas Facts." This book is carefully designed to provide industry statistics for financial people. If you do not have it, you should add it to your library. I have attempted rather to give you the philosophy and spirit that motivate our business. We of the gas industry are pleased that you invited us to appear before you. We recognize the important part the security analyst plays in the complex economic system of this Nation. You have a great responsibility in determining how, where, and when funds should be invested in all the varied industries of the Nation. We are a large industry, and our need for capital is never ending. We need your help, and we are happy to discuss our situation at all times with frankness and detail. On behalf of the more than 1,000 companies comprising the gas industry and the American Gas Association headquarters located here in New York, I extend an invitation for you to call on us at any time. As you know, the cold figures of a financial statement are only a part of good analysis. We will give you all the figures available, but we urge you to discuss our affairs with us in person. We are confident that, as an industry, we are moving ahead, and we urge you to join with us in making our contribution to the forward progress of this great Nation which we so proudly serve. (Applause)

* * *

Chairman Young: Thank you, Mr. Cuthrell, not only for the talk itself, but also for the invitation to accept your help in working on some of these problems. I know that all of us are most eager to keep in touch with the sources of information and to have access to just the kind of help that you offer.

We have six minutes remaining for questions.

Miss Thompson: Mr. Cuthrell, referring back to your statement that you believe you have a substitute for natural gas, am I correct in assuming that it is a new process? How far has it progressed, and what does it consist of?

Mr. Cuthrell: It is a new process. The most advanced research work has been done on oil. We are today making better than 1,000-Btu gas from oil which can be mixed with natural gas up to about 50% without in any way endangering its use in the home. That process is far enough advanced, I think, that we can safely feel that, within two or three years, gas can be made completely interchangeable with natural gas. In other words, we could shut off natural gas and make 1,000-Btu gas from oil where there would be no difference in the characteristics of the gas.

As for coal, some progress has been made, but it is much slower and will take a much longer time, probably ten years. But we have reason to believe it will be successful.

Mr. Schneider: That brings up the question that, since coal reserves are so much greater than oil reserves, should not the emphasis be on the coal process?

Mr. Cuthrell: Probably four times as much money is being spent on the research involving coal as is being spent on that for oil. However, our major effort is in oil, because we see a quick solution there, and there has to be a quick solution for this peak load on natural gas lines which they cannot supply.

Mr. Schneider: You are thinking, then, of the seasonal rather than the long-run replenishment.

Mr. Cuthrell: That is right.

Mr. Schneider: What about your cost factor?

Mr. Cuthrell: Well, we can make oil gas today, 1,000-Btu oil gas, at about 60 cents from one oil and from another process at about \$1.20. One process will cost about \$90,000 per unit, contrasted with \$15,000 per unit for the other. Both processes are being improved steadily, and those costs have come down radically even in the last year. We are fairly certain we can come pretty close to approaching what we call storage natural gas. In other words, to pump natural gas in a storage well and pump it out again will cost here in New York about 42 cents a thousand, contrasted with 33 cents we are now paying for it. We believe we can approach that figure, probably around 45 cents, for manufactured gas.

Mr. Davenport: The electrical industry, I judge, looks upon the heat pump as a source of great additional revenue. You mentioned that you have developed a gas heat pump that is even better. What would be the effect of that? I mean you are taking business with one hand while you are losing business with the other. Is that not true? What would be the over-all effect on the business?

Mr. Cuthrell: I should think it would improve the gas business. It would certainly improve our competitive position. Competition is the life of American business. We do not fear competition and never have feared it. We do have to meet, however, the electric heat pump situation, and our greatest method of doing that is the gas heat pump.

Mr. Davenport: If you sold the gas heat pump to a customer who is already heating with gas, would you sell him more gas or not?

Mr. Cuthrell: Well, you might or might not; but what difference does it make?

Question: Wouldn't that give you greater load stability?

Mr. Cuthrell: Yes.

Question: Would you care to comment a little on the conference you are having in Chicago . . . (the rest of this question was inaudible)?

Mr. Cuthrell: Here is what happened over the years. I gave you those figures of 110 and 118% in coal and oil and 2% in gas. In the Midwest some eighteen years ago the cost of house-heating gas—that is, not necessarily house heating but the lowest step in the rate that applied to house heating—in some instances was down as low as 40 cents, and in a great many instances 50 cents a thousand, and that is considerably cheaper today than oil or coal. The gas companies in those areas have not been allowed to raise their rates. We want to get the commissions to realize a more realistic rate structure in rate increases or rate decreases and have those increases and decreases apply more economically. The commissions want the rate increase to apply to all people, and that is what wrecked the rate structure of this country—both gas and electric—and we hope to find the real answer in having the commissions let us design our rates for the load.

Chairman Young: We have to gear this into the whole schedule and have to shut down now to permit you to get to your next forum at four o'clock.

Again I want to thank Mr. Cuthrell for his contributions. (Applause)

PACIFIC GAS AND ELECTRIC CO.

DIVIDEND NOTICE

Common Stock Dividend No. 144

The Board of Directors on December 12, 1951, declared a cash dividend for the fourth quarter of the year of 50 cents per share upon the Company's Common Capital Stock. This dividend will be paid by check on January 15, 1952, to common stockholders of record at the close of business on December 24, 1951. The Transfer Books will not be closed.

E. J. BECKETT, Treasurer
San Francisco, California



DIVIDEND NOTICE

The Directors of Daystrom, Incorporated (formerly ATF Incorporated) on December 18, 1951, declared a regular quarterly dividend of 25 cents per share, payable February 15, 1952, to holders of record January 18, 1952.

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The New and Old in Synthetic Fibers

THURSDAY AFTERNOON, NOVEMBER 8, 1951

OSCAR M. MILLER, chairman, presiding.
Chairman Miller: We have a rather comprehensive program scheduled. We have three eminently qualified speakers this afternoon to tell us about the developments in the field of synthetic fibers. The first speaker of the afternoon is Dr. Tesi of the Celanese Corporation of America.

He received his bachelor's degree in chemical engineering from the University of Pittsburgh in 1931, and he later received his doctorate in the same field.

He has been active in the field of synthetic fibers for twenty years, part of that time as a fellow at the Mellon Institute. He is obviously distinctly qualified to talk to us today. His topic is a long one. Its title is, "Man-Made Fibers with Particular Reference to Their Basic Raw Materials and Their Impact on the Economic Development of These Fibers." Ladies and gentlemen, it gives me great pleasure to bring to you Dr. Frank Tesi. (*Applause*)

* * *

A. Frank Tesi: Thank you, Mr. Chairman. Ladies and gentlemen: I assure you that the talk will not be as long as the title, so don't get worried. Now, I have prepared an envelope with quite a bit of material in it, which is directly connected with the talk. Of course, the talk will be of greater value to you if you have this material.

RAYON AND SYNTHETIC TEXTILES

The first pamphlet I want to refer to is not part of the talk, but I thought it would be of very great value to you because when you get back, and it is always nice to take something home, some of this material makes very good library or reference material. This particular document, called "Rayon and Synthetic Textiles: 1951 Survey on Types of Man-Made Fibers,"* contains considerable information on the types of man-made fibers that are being made, the number of filaments produced by the various companies, the types of fibers produced, and so forth. It may serve as a good reference point for you as you fellows go on with your researches.

With that bit of introduction, more or less, I will go into the formal presentation.

NO OLD MAN-MADE FIBERS

In any discussion of man-made or chemical fibers, one thing should be made clear, and that is that there are no old man-made fibers. All man-made fibers are new. None was produced in quantity forty years ago, although natural fibers have been known for thousands of years. For example, wool was used 8,000 years ago, linen 6,000, and cotton 5,500 years ago.

We wish to emphasize this because we are already beginning to hear about comparisons between the old and

the new man-made fibers. It is unrealistic to attempt to call fibers born only twenty-five to forty years ago *old*, when the natural fibers which have been with us thousands of years are still finding new uses. The opportunities for development of *all* man-made fibers are limitless.

BRIEF HISTORY

Perhaps a brief history of the growth of man-made fibers will serve to point out the present importance of these fibers and also give us some insight into their future possibilities.

Regenerated cellulose rayon was first produced commercially in 1911; the rate of its growth is shown in Table 1.

TABLE 1. PRODUCTION OF RAYON AND ACETATE*
 CONSUMPTION OF COTTON AND WOOL†

Millions of Pounds				
Year	Rayon	Acetate	Cotton†	Wool†
1911	0.4			
1912	1.1			
1913	1.8			
1914	2.4			
1915	3.9			
1916	5.8			
1917	6.5			
1918	5.8			
1919	8.2			
1920	10.0		2,828	314
1921	14.9		2,555	343
1922	24.0		2,910	406
1923	34.8		3,121	422
1924	36.2	0.1	2,637	342
1925	49.4	1.6	3,075	349
1926	60.1	2.6	3,215	343
1927	74.2	5.1	3,588	354
1928	91.4	6.0	3,184	333
1929	113.5	8.4	3,423	368
1930	117.9	9.8	2,611	263
1931	136.1	15.6	2,657	311
1932	117.5	18.3	2,463	230
1933	174.5	41.1	3,052	317
1934	172.5	38.0	2,655	230
1935	206.3	55.8	2,755	417
1936	224.7	65.2	3,470	406
1937	254.8	86.0	3,657	380
1938	207.9	79.6	2,918	284
1939	276.6	103.3	3,630	396
1940	327.7	143.5	3,954	408
1941	392.8	180.4	5,187	648
1942	432.1	194.5	5,637	616
1943	468.1	195.0	5,269	636
1944	511.9	212.0	4,729	623
1945	577.9	214.2	4,511	645
1946	623.9	230.0	4,803	748
1947	693.4	281.7	4,668	708
1948	746.8	377.5	4,461	705
1949	674.1	320.3	3,838	511
1950	815.8	443.6	4,720	637

*This pamphlet may be obtained from Rayon Publishing Corporation, 303 Fifth Avenue, New York 16, N. Y.

*Rayon Organon, February 1951, page 20.

†Rayon Organon, March 1951, page 43.

Commercial production of acetate was started by the Celanese Corporation in the United States in 1924; its phenomenal growth is also shown in Table 1.

ACETATE

The same more or less applies to acetate that was first produced by our particular company in 1924. Its growth is shown in the second column.

444 MILLION POUNDS IN 1950

We now get to a point where, in 1950, 444 million pounds of that particular type of man-made fiber were produced. As a matter of fact, when we take into account the strictly textile type of operation, that is, exclusive of the entire yarn part, we find that the acetate production and the rayon production are about on a fifty-fifty basis.

Nylon, the junior member of the big three, started commercially in 1939, and, although production figures are not published, it is estimated that the 1950 production was around 100 million pounds.

AN IMPRESSIVE GROWTH

This is an impressive growth, but, to get a true picture of what has happened, we must remember that the consumption of wool and cotton did not go down during that same period. The data in Table 1 show that very clearly. The consumption of cotton for 1924 was 2,637 million pounds. By 1950 it was 4,720 million pounds. You can see that that is quite an increase with, of course, variations in between. But the general trend was still up.

SAME THING APPLIED TO WOOL

The same thing applied to wool. The last column shows that in 1924 consumption of wool was 342 million pounds. In 1950 it was 637 million, revealing quite clearly, I be-

lieve, that the increase in production of man-made fibers did not cause a decrease in the consumption of natural fibers. However, there is some field for conjecture as to whether use of the one type of fiber might not have risen higher if the other had not been available. In other words, these man-made fibers, rayon and acetate and later nylon, did not cause wool and cotton consumption to decrease. They grew because they had something new to offer. The growth in population plus the added per capita consumption created its own market for these man-made fibers. As a matter of fact, they were in part responsible for the increased standard of living. The producers of these fibers made available to consumers fibers at a price they were able to pay, and the public used them in large quantities.

VARIETY OF FIBERS SINCE WORLD WAR II

Since World War II, a variety of fibers has come into being, and they have been referred to as the new man-made fibers. Actually, at this stage of their development, they might more properly be called specialty fibers because of their small production and because they are still being used more or less on an experimental basis. Not one of these fibers is being produced at a rate of more than one tenth of a pound per capita, enough for little over one square foot of fabric. Although the amount being produced today is small, present production plans when carried out will make these fibers available in considerably larger quantities.

WHAT IS HAPPENING

If you now refer to Table 3, you can see what is happening and what the best guessers in the game believe will happen up to 1953. That reminds me of Mr. Hazlitt who said that he was not going to do any predicting. He went ahead and predicted anyway, and so I will just go ahead and admit that I *am* going to do some predicting.

ESTIMATED PRODUCTION

Table 3 gives the estimated production of a number of man-made fibers for the years 1951 and 1953. In looking forward, we have chosen 1953 because that appears to be

TABLE 2. SOME MAN-MADE FIBERS AND THEIR RAW MATERIALS

Fiber	General Type	Basic Raw Materials
Rayon	Regenerated cellulose	Wood pulp and cotton linters Caustic soda Carbon bisulfide Sulfuric acid
Acetate	Cellulose acetate	Wood pulp and cotton linters Acetic anhydride Acetone
Nylon	Polyamide	Benzene, butadiene, Furfural, cyclohexane
Orlon	Acrylic	Acrylonitrile from acetylene, Ethylene oxide, HCN
Acrilan	Acrylic copolymer	Acrylonitrile Vinyls
Dynel	Acrylic copolymer	Acrylonitrile=40% Vinyl chloride=60%
Dacron	Polyester	Terephthalic acid (paraxylene) Ethylene glycol
Vicara	Protein	Corn protein
Saran	Polyvinylidene copolymer	Vinyl chloride Vinylidene chloride

TABLE 3. ESTIMATED PRODUCTION OF SOME MAN-MADE FIBERS OBTAINED FROM A VARIETY OF PUBLICATIONS AND FROM REASONABLE ANTICIPATIONS

Fiber	U. S. Production, Estimated, Millions of Pounds	
	1951	1953
Rayon	813.0	1,045
Acetate	419.0	553
Nylon	115.0	Possibly around 200
Orlon	8.0	40
Acrilan	1.0	30
Dynel	5.0	Possibly around 20
Dacron	3.0	35
Vicara	5.0	Plant capacity estimated at 25 (Amount limited by availability of Zein protein)
Saran	18.0	Possibly above 20

the year when all of the presently proposed plants should be in production. The figures are admittedly guesses, but we believe they are intelligent guesses and should be of value to you.

GLASS

Glass is included in many tabulations, and I debated in my mind whether I should include it but decided not to. Probably Mr. Bendigo may say something about glass.

Let us look at the 1953 estimates and see what will be their impact on the basic raw material markets. Table 4, taken from *Chemical Engineering*, August 1951, shows the various amounts of raw materials needed for the production of viscose, acetate, nylon, Orlon, Dynel, and Dacron. By simple calculations, we find that in 1953 these fibers will require the following amounts of raw materials. For viscose, 1.3 billion lb of pulp or linters, 1.7 billion lb of caustic soda, 4,000 million lb of carbon bisulfide and 2 billion lb of sulfuric acid (60 degrees Baume). Acetate should require 390 million lb of pulp or linters, approximately 400 million lb of acetic acid or its equivalent in anhydride, 110 million lb of acetone. Nylon should take about 130 million lb of adipic acid or sebacic acid and 110 million lb of hexamethylenediamine. The acrylics, including Orlon, Dynel, and Acrilan, will consume about 70 million lb of acrylonitrile. Dacron will undoubtedly use about 30 million lb of dimethylterephthalate and 11 million lb of ethylene glycol. These examples will serve to give you an idea of the potentials as far as raw materials are concerned. They are and will continue to be an even more important part of our American economy.

Some have even estimated that the products of one

fourth of the chemical industry go to textiles today, and, of course, if expansion takes place, maybe that proportion might even become higher. But it merely shows that textiles is a very important segment of the economy, regardless of either the synthetics or the naturals.

MAKING CERTAIN OF RAW MATERIALS

What is being done about making certain that these tremendous quantities of raw materials are available? You can be assured that the producer companies are looking ahead and making certain that they will not be stymied by lack of raw materials.

THE CELLULOSIC PICTURE

In the cellulosic picture, such developments as Columbia Cellulose Company, Limited, in Prince Rupert, British Columbia, where through constructive forest management the forests are perpetuated, help assure continuing supplies of wood pulp. Recently announced plans for similar developments in the Ketchikan area of Alaska will also provide cellulose for acetate and rayon manufacture.

CELANESE

Celanese is expanding its production of petrochemicals by expanding its present plant in Bishop, Tex., and building two new plants, one in Pampa, Tex., and the other in Edmonton, Canada. These new facilities will help supply the other basic raw materials: acetic acid and acetone for acetate production.

MONSANTO

As for raw materials for the acrylic fibers, a recent newspaper report said: "Monsanto Chemical Company, which is building a plant at a cost of approximately \$25 million at Texas City, Tex., has already received a 50% certification. Other companies planning production facilities are American Cyanamid and Union Carbide and Carbon." This indicates that acrylic fiber production will probably not be held up by lack of raw materials. As far as Dacron is concerned, at present, the terephthalic acid component is being made from paraxylene from the asphaltic base petroleum, and, unless other means of production are developed, terephthalic acid availability could limit its expansion. Terephthalic acid can be produced from pine stumps, but considerable research still needs to be done to make this method commercial. Other means of producing terephthalic acid are undoubtedly being investigated.

ETHYLENE GLYCOL

I do not think there is much need to worry about ethylene glycol because it is made in such large quantities that the 11 million pounds that are needed would not cause much difference.

NYLON

As shown in the table, nylon can be produced from at least four basic raw materials and production and facilities are being increased so that in nylon also there is little likelihood of expansion being curtailed by a lack of raw materials.

So far we have said very little about the all-important

TABLE 4. QUANTITIES OF RAW MATERIAL REQUIREMENTS FOR SOME MAN-MADE FIBERS*

<i>Viscose Rayon, Chemicals Used per Lb</i>	
Wood pulp, linters	1.25 lb
Caustic soda	1.60 lb
Carbon bisulfide	0.38 lb
Sulfuric acid, 60 Baume	1.90 lb
<i>Acetate Rayon, Chemicals Used per Lb</i>	
Cotton linters	0.7 lb
Acetic acid or anhydride equiv	0.7 lb
Sulfuric acid	0.1 lb
Acetone	0.2 lb
<i>Nylon, Chemicals Used per Lb</i>	
Adipic acid	0.620 lb
or	
Sebacic acid	0.665 lb
Hexamethylenediamine	0.554 lb
<i>Orlon, Chemicals Used per Lb</i>	
Acrylonitrile	1.0 lb
Dimethyl formamide	0.2 lb (approx.)
<i>Dynel, Chemicals Used per Lb</i>	
Vinyl chloride	0.6 lb
Acrylonitrile	0.4 lb
Acetone	0.2 lb
<i>Dacron, Chemicals Used per Lb.</i>	
Dimethylterephthalate	0.86 lb
Ethylene glycol	0.31 lb

*From *Chemical Engineering*, August 1951.

factor: price. I do not need to tell you that it is almost impossible to calculate with any degree of accuracy what the cost of a finished fiber is from the costs of the raw materials. Such factors as capital investment, yields, depreciation, and taxes enter the picture. Here again, I believe we can say that, if we study all these important factors and reach some conclusion, we find that four groups emerge as follows: The nylons are the highest in cost, next comes the Dacron type, then the acrylics, and the lowest are the cellulosic. As to the spread between the nylon and cellulose, little can be said. However, if the present activity in acrylics is any guide, we could infer that the acrylic could be *closer* to the cellulose than to the polyesters (Dacron).

FUTURE POSSIBILITIES

Having reviewed the raw material picture as far as the general synthetics are concerned, let me discuss briefly the future possibilities in the cellulose, particularly acetate. As stated before, the growth in the rayon and acetate field has been phenomenal and we believe that the possibilities are still limitless. As an example, I refer to the possibilities of rayon or acetate staple fiber going into some of the applications now monopolized by cotton. The price is not too far off, you know! Today's cotton runs around 40 cents, viscose 41 cents, acetate about 48 cents; if we take into consideration probable processing costs, the costs really are not too far apart. They fall within a common range.

BASIC FIBERS

We believe acetate and rayon are basic fibers that combine a number of very desirable properties, some of which we ourselves have not yet discovered.

FIELD HARDLY TOUCHED

In considering the opportunities for acetate and rayon, it should be emphasized that the whole field of modification of these fibers has been hardly touched. However, Fortisan, the regenerated cellulose extremely strong fiber, is made from acetate; Celcos, the very useful carpet fiber, is also a modified acetate. Fiber E can be considered to be a modified rayon. Another example shows the possibilities. It has been found that, by altering acetate staple, by giving it a larger diameter, incorporating greater resilience, and adding crimp, this fiber can be made very suitable for carpets. The possible poundage in this use alone could run over 100 million. New uses that might be brought about by

1. Change in cross section
2. Variation in degree of crimp
3. Change in stiffness
4. Alteration of the elastic properties
5. Changes in chemical composition

await the reports of the research workers.

ONE STAGE OF PRODUCTION

As you probably know, one of the stages in the production of acetate involves the making of a solution. We call it dope. By adding various substances to the solution, it might be possible to produce fibers with almost any de-

sirable properties. A good specific example of this was mentioned last week in the trade papers. The article in question mentioned that acetate yarn that had been dope-dyed was now being marketed. In other words, the pigment was added in with the solution and a colored yarn spun. Because the dye is all the way through, the color is very fast to sun, washing, perspiration, and other color-destroying agents.

DOZENS OF EXAMPLES

I could name dozens of examples, but it is now time to summarize and close.

1. There is really no such thing as new and old man-made fibers. Neither have been with us long enough for us to know what they can do. The advantage that acetate and rayon have is that they have been tried in the rough field of textile competition and have been found satisfactory. This is attested to by the consumption which runs over a billion pounds.

2. Raw materials for practically all the man-made fibers will undoubtedly be available as indicated by the present expansion plans.

3. When large-scale production of all these fibers is with us, *quality* at a *price* will be a determining factor. Acetate and rayon, because they combine these two factors to the optimum, will continue to be the basic fibers that will serve as the foundation for building more and better fabrics. (*Applause*)

* * *

Chairman Miller: Thank you, Frank. That was just fine.

Our second speaker of the afternoon, Mr. C. W. Bendigo, of American Cyanamid Company, has been connected with the textile industry since 1933, and his specialty has been synthetic fibers. He gained his basic training with Burlington Mills and Deering Milliken. In 1944 he joined the *Textile World* magazine and two years later became the editor-in-chief.

He was also editor of some of their technological series, especially in the textile field, published by McGraw-Hill.

He is probably best known in the field of—and I think many of you have seen his compilations—the properties of synthetic fibers which appear in chart form in *Textile World* every second year.

In February of this year, Mr. Bendigo joined the new product development department of American Cyanamid to specialize in the development of synthetic fibers. He will speak to us this afternoon on the properties and future of synthetic fibers. Mr. Bendigo! (*Applause*)

* * *

C. W. Bendigo: Thank you, Mr. Miller. Ladies and gentlemen: Dr. Tesi has already given you an excellent description of the importance of man-made fibers, both volume-wise and as huge users of chemicals.

IMPORTANT PROPERTIES

Shortly Mr. Spiro will tell you how these fibers are used now and how they will be used in the immediate future. But first I shall try to explain some of the important prop-

erties that the various synthetic fibers have. These properties will foretell much about their growth potential—but not all. Other factors which must be considered are (1) availability of raw materials, (2) cost or price of the fibers, and (3) the vigor with which they are developed and promoted.

ASPECT OF AVAILABILITY

Dr. Tesi has covered the aspect of availability of raw materials. I shall devote myself to properties, costs, and what the future should hold—with emphasis on the newer synthetics: nylon, the acrylics, polyester fiber, Saran, Azlon, and Vicara.

EXAMPLES OF NEWER FIBERS

I will ask Dr. Tesi if he will help me just a minute to show you examples of each of the newer synthetic fibers that are commercially available.

(As Dr. Tesi held up each of the following examples of fiber, Mr. Bendigo identified them):

Nylon continuous filament; Orlon staple; Orlon continuous filament, and some fabric underneath it of both types; Acrilan staple—and I apologize because this is a couple of months old, but the latest is a slightly superior type; Acrilan fabric; Dynel staple, and several examples of Dynel fabric; Dacron staple; Vicara staple, the unbleached type. This month there is also available a bleached type which, unfortunately, I do not have to show you. Then we have Saran staple, and this is probably the first time many of you have seen Saran staple.

FIBERS QUITE DISSIMILAR

To the eyes of nontextile men there may seem to be many points of similarity; but the fibers are actually quite dissimilar.

NYLON

Let us take nylon first, because it is today the number 2 synthetic fiber poundage-wise. The biggest use for nylon is in filament form because of its inherent fineness, strength, toughness, and elasticity. No other textile fiber has a similar combination of properties. Its use for full-fashioned hosiery is unchallenged. It is also finding use in many fabrics for women's wear, but in this it has much competition, especially from acetate. The price and, to a lesser extent, the feel of nylon are limiting factors. For many industrial and military uses it cannot be beat. Note that the 50 million pounds of nylon to be produced by Chemstrand Corporation will be filament yarn.

NOT MUCH STAPLE AVAILABLE

Not much nylon staple is available, compared to filament; and there are not many 100 per cent spun-nylon fabrics, despite the strength and wear resistance of the staple. However, it is a marvelous blending fiber. Very small amounts add surprisingly to strength and wear resistance. It is best blended with those fibers that are warm to the touch and that absorb moisture, to improve the feel of the fabrics.

For ultrafine filament yarns, for fibers that add strength

and wear resistance—look to nylon. Continued relatively high price must be expected; and, barring war, the 200 million pounds projected by Dr. Tesi will be something of a plateau for the immediate future.

ACRYLICS—FOUR TYPES

Whereas nylon's major field is in filament form, that of the acrylic fibers is in staple form. Today the larger poundage available is in filament form, but by 1953 staple production will outstrip filament ten times over: 8 million pounds to 80. Today the ratio is 6+ to 6—. Acrylic filament is the most durable fiber available. It is especially resistant to weathering. In staple form it is very warm, possibly the warmest clothing fiber we have. In either form acrylic fibers are dimensionally stable—more stable than rayon, acetate, and nylon; and certainly much more stable in fabric form than wool or cotton.

A WHOLE NEW CLASS

Most persons do not realize that acrylic fibers represent a whole new class of synthetic fibers. The four types available commercially today differ among themselves more than do viscose and acetate. These four types are: Orlon filament, Orlon staple (chemically the same but physically different), Acrilan staple, and Dynel staple. The last is the only one that is flame-resistant, but offsetting that good property is a much lower softening point than is found in Orlon or Acrilan.

3 COMPANIES PRODUCING ACRYLICS

Three companies are today producing acrylic fibers: duPont, Union Carbide, and Chemstrand. At least four more are seriously considering the field. In other words, half as many companies are today seriously interested in acrylic fiber production as are interested in the billion-pound rayon, acetate, and cuprammonium field.

COST

Today the cost of acrylic fibers (staple) is from \$1.25 to \$1.90. Two types are the highest in the synthetic fiber field. They can be so because their properties permit outstanding fabrics of the wool type with many points of superiority over wool: greater strength; increased wear, easy launderability, inherent mothproofness, dimensional stability. No wonder I agree with Dr. Tesi that the acrylics are destined to reach second place in the synthetic fiber field this decade. A great potential advantage they have is price. A low price will depend on new acrylonitrile facilities and the already advanced technology of fiber production.

POLYESTER

The nearest fiber property-wise to the acrylics is the polyester Dacron produced only by duPont in the United States. In England the fiber is known as Terylene. Dacron has excellent wrinkle resistance and recovery both wet and dry, high stretch resistance (not so elastic as nylon), and good tensile strength. Its strength can be made to equal that of regular nylon but probably will not be. It does not have the weathering resistance or warmth of the acrylics.

Dacron is available in both staple and filament forms. Staple—at \$1.80 a pound—is finding greater acceptance

than filament yarn. Filament yarn is priced just under Orlon, the highest-priced filament for the sizes produced. That price picture is as of today. In the future, it is not at all likely that staple polyester fiber can compete pricewise with the acrylics. Filament will compete more closely with nylon and may be a good number 2 fiber for many military uses—but more about that later.

SARAN

Although many synthetic fibers can be made in monofilament form, this field is today considered as being composed principally of Saran. (The 15-denier nylon used in sheer women's hosiery is a monofilament—but that is not here being included for the sake of simplicity.)

A GENERIC TERM

Saran is a generic term applied to wirelike monofilaments of vinylidene chloride, priced from 65 cents to \$1.15. An early important use was in screenings—and still is. Saran is found in automobile seat covers and many specialty fabrics. Once spun, the yarn cannot be dyed commercially. This factor and the low melting point of the fiber are its principal drawbacks. The monofilaments are reasonably strong and quite durable even to outdoor exposure. In monofilament form not much production expansion is seen, barring war; but Saran might find new fields in staple form.

Recently Dow and National Plastics formed a company, the Saran Yarns Company, to develop multifilament and staple Saran. The staple seems to have a future in such things as floor coverings and possibly half-hose. It can be used where it will not come in contact with much heat; and, as with monofilaments, it cannot be dyed after it is spun. It should be a relatively low-cost staple.

AZLONS

The last fiber I shall go into is the one Azlon—protein type—that we have: Vicara. It is made from zein (corn protein). The fiber is produced in the former Aralac plant. Vicara is quite wool-like, even to the property of being weak. It is promoted well as "the fiber that improves the blend" for it is, essentially, a blending fiber. It can be mixed with wool to add softness (and keep down price). It is a natural for blends with nylon for half-hose. It dyes easily, sometimes too easily in that it steals dye from the fiber with which it is blended. It costs about a dollar a pound. Limiting factor even today is the amount of zein available. I say "even today" remembering that the textile industry is at a temporary low point. Despite the low point, in general synthetic staples seem to move well.

GLASS FIBERS

I shall not touch on glass fibers despite their growing importance, especially in the industrial fields. They were covered, I believe, at the panel meeting in this room this morning. During the question period I shall be glad to answer what questions I can on glass fibers.

PROPERTIES OF SYNTHETIC FIBERS

I might point out that I have brought with me several copies of a new chart which lists the properties of all syn-

thetic fibers available in the United States and from whom each can be obtained and in what form. Should more of you need copies than I have brought I shall be glad to advise you where additional ones can be obtained.*

USE SPECIFICATIONS

This chart lists only U. S. fibers, but there are available in the United States several for which we have no counterpart: alginates, polyvinyl chloride types. In all, there are at least 70 distinct types of synthetic fibers, each of which can be identified as being distinct from every other.

CHANGE IN THINKING NECESSARY

With so many fibers now available—and more surely to come later—a fundamental change in thinking must take place in regard to articles manufactured from fibers or fabrics. At present virtually everyone wants to know if a textile article is made of cotton, wool, rayon, or nylon. In many cases information is not available, and in virtually every case information concerning fiber content can be grossly misleading. The degree of confusion today regarding fiber content of fabrics is rapidly becoming hopeless. The general public must forget fiber content and insist on use specifications. Mr. Spiro will give you more evidence as to why it is essential for all but technicians to forget about fiber content and to demand that textile products are guaranteed suitable for the uses for which they are intended. I shall be glad to go into some of the ramifications of this subject during the question and answer period, if you wish me to do so.

WHAT ABOUT WAR

Many of you would like to know how World War III might affect synthetic fibers. It goes almost without saying that the military would take virtually all nylon. For women's hosiery, rayon might have to take over as it did before, although filament Dacron might be better suited.

MILITARY WOULD TAKE OVER WOOLS

It is not so well understood that a war any time the next five or ten years would mean that the military would have to take over most stocks of garment-type wools. Such a condition would speed production of acrylic fibers as World War II did for nylon. The acrylics and whatever polyester is available would be used in blends with wool by the military and in blends with viscose and acetate for civilians. (The civilians might be getting the better deal!) Several hundred million pounds would be needed quickly, perhaps more quickly than acrylonitrile plants could be built—but no other fiber so suitable for warmth purposes could be brought into production so quickly. The final result would be freedom from depending on outside sources for half our clothing wool needs, and better fabrics for easier living.

BETTER FABRICS IN THE FUTURE

War or not, the properties of the 70 varieties of synthetic fibers available today will mean better fabrics in the future.

*Textile World, Synthetic Fiber Chart 1951, McGraw-Hill Publishing Company, 330 West 42d Street, New York 18, N. Y.

You will hear about some of the more interesting in a few moments from Mr. Spiro. (*Applause*)

* * *

Chairman Miller: Thank you very much. We are about half through our allotted time, and, although this is not the seventh inning, we might stand up for a stretch, if you like.

(*Five-minute recess*)

Chairman Miller: Our third speaker of the afternoon who is Mr. Arthur Spiro of Robbins Mills is also a chemical engineer from Clemson College. He spent quite a number of his years—as a matter of fact, a rather sizable portion of his lifetime to date—in the Navy, but he still had time after that to get his master of science from MIT.

For the past five years, he has been with Robbins Mills. He has run the gamut, coming up from research and quality control work to his present position as assistant to the vice-president of the corporation in charge of production.

From point of age, he is the newest element on this program. From point of position, as has been mentioned before, he stands in the middle between the mills that produce the fiber and the public that consumes his synthetic fabrics.

Mr. Spiro will speak to us today on the subject of textile mills keeping pace with fiber development. Mr. Spiro! (*Applause*)

* * *

Arthur Spiro: A very wise man, who pioneered in the development of rayon fabrics, tells this interesting story that took place some thirty years ago.

While displaying his line of rayon dress fabrics to one of the largest cutters in New York, he was asked: "Why do you make these rayon fabrics and experiment with the problems of a new fiber when silk is so beautiful and gives us so much?"

The wise man answered: "I have more faith in the product of the chemist's mind and the test tube than I have in the rear end of the worm."

PIONEER'S VISION A REALITY

Today, more than thirty years later that pioneer's vision has become a reality. Fabrics woven of the basic rayons, viscose, acetate, and Bemberg, together with nylon, the first of the truly chemical fibers, have all but completely replaced silk.

GROWTH OF THESE FIBERS

It is interesting to note the growth of these fibers—from 1920 to 1950 based on the over-all percentages of total fiber consumed in the United States (Table 1).

TABLE 1

	% Cotton	% Wool	% Silk	% Flax	% Rayon & Other Man-Made Fibers
1920-24	33.2	12.9	1.9	1.2	0.8
1930-34	81.4	9.6	2.5	1.2	5.3
1940	79.4	9.2	1.0	0.5	9.9
1949	68.7	11.3	0.1	0.4	19.5

I am sorry that the program for your meeting was printed before we had the opportunity to comment on the title of the subject matter being discussed.

SYNTHETIC HAS DUAL MEANING

The word "synthetic" has a dual meaning. To the chemist it implies a substance that is synthesized or formed in the laboratory. To the layman it definitely gives the impression of being synonymous with "artificial substitute." Chemical fibers are not "artificial substitutes" for anything, and we would, therefore, like to refer to them from this point on as "man-made fibers."

NOT SUBSTITUTES FOR WOOL

Neither acetate nor viscose rayon fibers are substitutes for wool fiber. There is no chemical similarity between the two—the physical properties greatly vary within themselves, and under the microscope these fibers do not even closely resemble wool fiber. The same type of analogy applies in comparing Bemberg or nylon to silk. These chemical fibers do not resemble the natural fibers any more than aluminum is a substitute for iron, although both are metals.

WOOL A WONDERFUL FIBER

Wool is a fine and wonderful fiber. We are certain that nature made it principally to keep the sheep warm and not to keep man warm. By his ingenuity and creative ability, man has taken this product of the sheep and developed yarns and fabrics which have performed and served him well for nearly 6,000 years, dating back to the Babylonian days of 4,000 B. C. I think that Dr. Tesi and Mr. Bendigo would admit that it would be an almost impossible task to synthesize wool fiber commercially by chemical methods, not to mention the fact that the cost of doing so would be prohibitive. Nature plays its little tricks like putting scales on wool, similar to fish scales, which the chemist cannot duplicate. We, therefore, resign ourselves to the fact that we cannot match nature in duplicating wool or silk exactly by chemical methods. Therefore, in the true sense of the word, "there is no substitute for wool fiber."

You men, I am told, are research people in your field, just as chemists and technicians are in ours. Therefore, you will not be misled by this last remark.

WE DO NOT WEAR WOOL FIBERS

We do not wear wool fiber—but rather, we do wear fabrics woven of wool fibers. Although there is no substitute for the wool fiber itself, we can make and are making fabrics using man-made fibers which are better performing and more economical than 100% wool fabrics today.

TABLE 2

Year	Per Cent
1946	19.7
1947	20.2
1948	24.1
1949	30.4
1950	37.1
1951	58.0

To touch on the development of suiting fabrics in particular, we can trace the growth of the summer suit containing man-made fibers based on the total number of cuttings each year for the past six years! The percentage figure quoted is that portion of the total number of men's suits cut containing more than 50% of man-made fiber in the fabric (Table 2).

25% MORE CUTTINGS IN 1950

Noteworthy also is the fact that 25% more cuttings were made in 1950 than in 1949, and the same results will no doubt apply in 1951 compared to 1950. This proves that the average man is now buying more summer suits than ever before, because he gets more for his money in style, comfort, and performance than he ever did.

YEAR-ROUND HEAVYWEIGHT SUITINGS

From the summer weight suiting field, Robbins Mills introduced development of man-made fibers in "year-round" heavyweight suitings with the completion of our Aberdeen, N. C., plant in 1947. We are now entering our fourth season in the "year-round weight" suiting field. 1950 also saw the introduction of men's top coats and sport jackets made of 100% man-made fibers.

What effect then will the introduction of Orlon, Dynel, Acrilan, Dacron, and the other new fibers have on acetate and viscose rayon consumption in a field like menswear suiting fabrics?

ONLY TIME WILL REVEAL ANSWER

This is a good question; only time, of course, will reveal the true answer. It is our belief, however, that, in this field where we have hardly begun to scratch the surface in man-made fibers, the introduction of new chemical fibers will increase the demand for viscose and acetate rayon in this end use.

We have seen several remarkable fabrics made of 100% man-made fibers. In our own company, for the past two years we have conducted wear tests under all types of conditions on 100% Orlon suits in 14-ounce "year-round weight" constructions and 11-ounce tropicals. We note comfort, bulk without weight, a very pleasant hand, and many physical properties which have amazed us. We have seen 100% Orlon slacks, covered with grease and dirt, thrown into a washing machine, then hung up to dry, and then worn the next day without the need of pressing.

A 100% Dacron tropical suit has been marketed commercially for the past two seasons and has exhibited remarkable physical performance characteristics in wrinkle recovery and crease retention.

Although none of us goes swimming or into the bathtub with our clothes on while we are sober, we have seen a good deal of publicity given to the newer fabrics of 100% Dacron content which have been put through these tests and then have been fit to be worn without any pressing or ironing or cleaning.

Blending, or the mixing of fibers, is the key to development of many fabrics—particularly suitings. In this respect, the textile technician has many tools to work with. These basic fiber tools have known functional properties of performance which can be measured and compared. The

wool fiber itself is now a blending tool in many fabrics.

If we stop to think for a moment, we will realize that steels used for turbine blades and valves must have different requirements from those used for cutlery knives, and both of these differ from the steels required for chemical purposes and bridge constructions. The engineer accepts the fact as common knowledge that high contents of manganese, added to carbon steel, greatly increase abrasion resistance and make the ideal product for grinders and crushers.

BLENDS FOR OPTIMUM PERFORMANCE

Look closely around you, and you will see that, in every field of manufacture where scientific engineering research has been applied, blends are the result for optimum performance results.

Fuels, lubricants, metals, paints, plastics, adhesives, insulating materials, concrete, glass, and rubber are but a very few to name.

There are certain exceptions to blending perhaps, such as the 100% Dacron and 100% Orlon fabrics that we previously discussed. This also applies to 100% nylon hosiery or 100% viscose rayon tire cord or 100% fiber glass draperies, where we might be looking for the outstanding functional properties contributed by one fiber alone.

NO UNIVERSAL FIBER

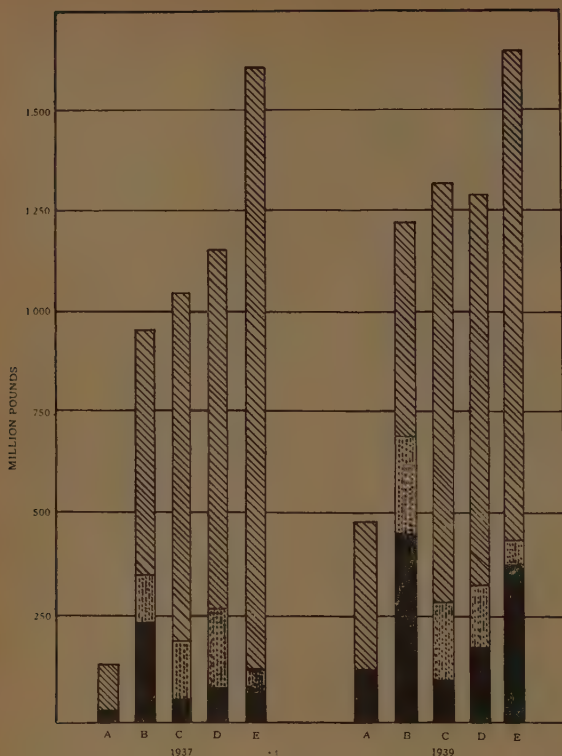
We know, however, that, in general, there is no universal fiber. Starting with the known end use of the fabric, it is our responsibility to blend fibers in their proper proportions, according to their functional properties, so that we can offer the consumer the best possible performing fabrics and value.

We believe that these blends should be made in the proportions required to give the best end-use performance. This requires research, and testing on the part of the mill and, ultimately, the consumer, who is the judge in the last analysis.

I have no fabrics to display, but I happen to be wearing a 14-ounce year-round suit, which is just one of those experiments. It is a blend of 35% viscose and 35% acetate. Throughout our company other executives subject fabrics we make to the same types of wear tests, and I am sure that our progressive competitors are doing the same thing.

Blended fabrics should be sold on performance characteristics and not on the percentage of nylon, Dynel, Acrilan, or Orlon. Performance characteristics include hand, appearance, warmth, resistance to abrasion, wrinkle recovery, in whatever particular end use the garment may be subjected to.

Certainly a coal miner's garment would have different end-use requirements from the clothes worn by a worker in a chemical factory, and both these types of fabrics require different end-use performance from a man's sport jacket. Toward this end, the miner's work clothing might be a blend of viscose and nylon which would have a high resistance to abrasion. The chemical worker's clothing certainly should have an acrylic fiber content to resist chemical deterioration, while the leisure sport jacket might embody some percentage of acrylic fiber or Vicara to add a



End-Use Consumption of Textile Fibers, 1937-49

Solid—Man-made fibers

Dotted—Wool

Diagonal lines—Cotton

A. Exports of domestic products

B. Women's, misses', children's, and infants' apparel

C. Household uses

D. Men's and boys' apparel

E. Industrial and miscellaneous uses

soft touch blended in with basic acetate and viscose fibers and possibly some Dacron to add resistance to wrinkling.

BECOMING MORE OF A SCIENCE

Fabric development in textiles is surely becoming more and more of a science. This revolutionary approach stems from these new fiber developments which makes it mandatory to do more and more engineering of fabrics with a view toward giving better performance to the consumer. In past years the technician gave most of his time to styling a line of apparel fabrics for pattern, color, and hand, but today he must also consider performance.

Research is now a necessary phase of fabric development in which we catalog performance tests in an effort to determine just how these functional fiber properties translate themselves into fabric.

We, at Robbins Mills, have included in our line of

spring fabrics for 1952—currently being shown—three different fabrics containing blends of Dacron with viscose and acetate yarns in men's tropical suitings. We have a menswear flannel fabric which is being made for rainwear with a water-repellent finish on a blend of viscose and Orlon. In Acrilan we have a "year-round-weight" suiting fabric in which this fiber is blended with viscose and acetate. We have a sport jacket and topcoat fabric in which Dynel is blended with viscose and acetate. We believe that all these fabrics offer the consumer more in performance and value than we previously had been able to make with only viscose, acetate, and nylon at our disposal.

NEW MANUFACTURING TECHNIQUES

Parallel with the new fiber development in the last few years has been the development of new manufacturing techniques and processing methods. This phase of progress is necessary to translate the functional fiber properties into yarns that can give the best performance in fabrics. Spinning techniques and machinery have been revolutionized. We at Robbins Mills have maintained a pilot plant operation under the closest supervision for the last year which today is the basis for an entirely new system of spun yarn manufacturing. This system is now beginning commercial operation in our new Raeford, N. C., spinning and weaving plant for suiting fabrics. We have made appreciable strides in dyeing and finishing development as well in an effort to use the new fibers more intelligently to their best advantage. These techniques, we find, also enhance the properties of the basic viscose and acetate rayon fibers.

To discuss at length the various fabric developments in the many end uses of man-made fiber would be quite a lengthy task. Volumes could be written describing the progress that has been made in our industry in each of the many end uses of fabrics of man-made fibers. Briefly, for your information, we should like to cover the end use percentage of all man-made fibers in 1949 (Table 3). These figures are based on millions of pounds used.

MAN-MADE FIBERS IN EACH INDUSTRY

Table 4 shows the percentage of man-made fibers used in each of the listed industries. These industries used an average of 18.9% of man-made fibers in 1949. These figures tend to give you some idea of the fact that we have made much more progress in the field of women's wear than in the field of men's wear in that, roughly, 40% of the women's fabrics used contain man-made fibers. That

TABLE 3. END-USE CONSUMPTION AS A PERCENTAGE OF FIBER USED IN 1949

Mens & boys	12.0
Womens & misses	37.6
Childrens & infants	2.1
Household	7.0
Industrial & misc.	32.0
Export	9.3
Total	100

TABLE 4. CONSUMPTION AS A PERCENTAGE OF EACH END USE

Mens & boys	10.5
Womens & misses	44.1
Childrens & infants	8.9
Household	6.0
Industrial & misc.	21.8
Export	21.4

gives you an indication of the potential that still exists in the men's wear field.

GREATEST DEVELOPMENT AHEAD

At that, we believe that the greatest period of development still lies ahead. The next ten years should see a completely thrilling revolution in the textile industry which will be our parallel to other contemporary fields of scientific progress, such as television and atomic energy. The path, however, is not an easy one, and we must prove our way with facts as we go along. An occasional poor model may be developed, in much the same manner as the automobile producer once in a great while turns out a poor car.

PITFALLS HELD TO MINIMUM

These pitfalls will be held to a minimum, however, by the textile mills who will take these functional chemical fibers and do an intelligent job of developing, styling, testing, and merchandising quality fabrics that will give the consumer greater end-use performance and value than he ever dreamed possible.

We believe that newer and better fabrics made of man-made fibers are in your life for good! (*Applause*)

* * *

Chairman Miller: Thank you, Arthur. Thank you all for what I believe was really an excellent coverage. We have maintained our schedule. We started ten minutes late. We are now just about ten minutes later than we had anticipated. We do have about fifteen or twenty minutes for questions.

Warren Wells (Baker, Weeks & Harden): I would like to address this question to Mr. Bendigo. Frankly, as an aid to the chemical portion of the analysis, I note that the usage of chemicals is very much higher in viscose rayon than in the other synthetic fibers. I would like to get a rough idea, however, of the cost factor of the chemicals used in viscose compared to the others; also, some rough idea of the usage of chemicals involved in the processing of cotton. I believe there is a certain amount of usage.

Dr. Tesi: We hate to be ducking out. There are a lot of good answers to that question. It's like the alibi: "I know all the answers. But to that one I'm afraid my brother knows the answer." I do not think I can really answer that question because it certainly involves a lot of research, if you wish to call it that, and a lot of investigation into all sorts of raw material processes and methods of making these things that you cannot just read off the cuff. So, I'm sorry, but that's as much as I can say.

Mr. Bendigo: I realize the question was addressed to me, but Frank actually had the chemical aspects. Now, so far as the amounts of chemicals used in cotton are concerned, you can get that information in detailed form. It's a terrific list written by George Buck, National Cotton Council, Memphis, Tenn. He has those figures.

I have copies of the list in my office, but I would be foolish to try to recall them from memory, and they are really enormous. He goes into things all the way from the fertilizer to the cotton to the materials that are used in the finished fabrics. I am sorry that I don't have them here with me.

Oliver Grace (Sterling, Grace & Co.): Could you clarify for me the processes and end uses of staples and yarns?

Dr. Tesi: That involves a fundamental textile concept, let us say. In making what we call a filament yarn, the yarn is spun directly. Particularly in the acetate process, we have this "dope" which we expurgate through a spinneret. We end up with a yarn that is ready to be made up into a fabric. Then it can be woven and finished and dyed ready for use.

Now, in the staple—and I assume this is what you are interested in—we start with a short fiber which is similar, of course, to the old cotton idea. In other words, cotton grew that way. By means of various processes and machinery, combing and carding, we parallelize these fibers and put them into a position of entanglement with each other, so that we end up with a yarn that is then woven into a fabric. That is the fundamental difference.

In one instance we have a filament all ready to use, and in the other it requires a lot of processing which, in many cases, is quite an expensive operation.

Mr. Spiro, do you want to add anything to that?

Mr. Spiro: I think I could draw a good comparison, Frank. Just going back over what Frank said, silk itself, in the natural form in which it is made, is a continuous filament yarn which is much like nylon or Orlon and has the same relative physical characteristics in that it is one continuous length.

The staple fibers, however, are cut, of course, into any given length and then have to be manufactured into a yarn just as wool fleeced off a sheep's back or cotton taken out of a bolt.

The processes for translating the cut fibers into yarns are many. I might add that there is one new form somewhere halfway between these two products of continuous filament and staple fiber. That product is being delivered and is called "tow." It is, in essence, a very heavyweight continuous filament which the mill then receives as such and cuts up itself. Then, it goes about translating it into a yarn.

Question: What is the difference in the end product of spinning the staple into a yarn and using the filament itself?

Mr. Spiro: They have entirely different characteristics in fabric form. A lingerie fabric, which some of you may be acquainted with, is principally a continuous filament yarn giving a smooth, flat touch. It may be soft or harsh, but it nevertheless has a smooth surface.

A worsted type of yarn which would go into this type

of suiting, even though it is a man-made fiber, would give a spun or a coarser appearance, which is desirable in a suiting or in a coating or some such type of fabric, each having a difference in appearance characteristics.

A spun yarn has greater bulk than a filament yarn, because there are air spaces and pockets in between the fibers as they are laid together in spun form.

Question: Mr. Spiro, you said that the suit you have on was blended with three types of man-made fibers. How do you blend those together? Don't you twist the threads together before you weave the product?

Mr. Spiro: The manner in which these fibers are blended can best be illustrated by what Frank said. If I had these three component fibers and I wanted to make this particular fabric, I would take one of the yarns which might be a blend of 30% Dynel, 35% viscose, and 35% acetate. As the fibers are received in the initial operation which we call blending in spun yarn manufacturing, they are weighed out and blended by weight into the first operation which we call a blender and picker. Then, they are carried through the entire sequence of yarn manufacturing in that same proportion in which they were introduced in the blending machine right through to a finished yarn.

By the same token, I could start with a 100% rayon instead of 30% of each of the three fibers, and I could carry them through the same operation of carding and spinning and then end up with a 100% rayon yarn. Does that answer the question?

Mr. Johnson: I would like to inquire what the investment or capital requirement may be for a woolen mill to convert to the use of blended or synthetic fibers. In other words, does the mill have extensive flexibility?

Mr. Spiro: I think the best answer to that question lies in whether the woolen mill has the will or desire to utilize the synthetic fibers, or man-made fibers, as we would like to call them. Certainly, if they went to the extreme of disposing of whatever machinery and equipment they have, they could readily institute processes which would be more adaptable to man-made fibers. But certainly it is established that blends of man-made fibers can be introduced on the existing equipment today in a woolen or worsted plant to incorporate these new fibers.

I believe one of the larger mills in the United States which was formerly associated principally with 100% woolen fabrics is today making a blend of 55% Dacron and 45% wool on the same system of manufacturing that they formerly used for 100% woolen fabrics. Not to draw attention away from that, we might add that newer machinery and equipment is being developed at the present time and will be continually developed in the next few years, this equipment being specifically designed to handle these fibers; so it is a question of economics as to whose system will be the more economical system, the most efficient, and—more than that—the best system for making quality yarns and fabrics out of man-made fibers.

It is my belief that there will be new systems of spinning and yarn manufacturing which will have to be adapted specifically to these fibers to get the best performance results out of them.

Woolen mills, however, as they exist today, can handle these fibers.

Chairman Miller: That's fine. I think that, without figures, it was a very complete answer.

Question: When these man-made synthetic fibers and suitings hit the market, Mr. Spiro, will they be able to cope with the mills that operate in competition to them and guarantee a sufficient profit margin?

Mr. Spiro: Let me clarify your question. You are asking whether the man-made fibers will compete with the natural fibers?

Question: That's right. And will that competition lower the whole price of men's suits?

Mr. Spiro: I think there is no question but that it is definitely going to lower the price of men's suitings. To offer an illustration, perhaps, wool tow has ranged in price from a low, possibly, of \$1.90 or \$1.85 a pound during the past depression up into the range of \$3.25 per pound six or eight months ago, while the man-made fibers, acetate and viscose, have been selling in a range of 40 to 50 cents a pound. There is no telling how low wool can fall if wool just becomes a by-product of the lamb chop.

If we all decide that we don't like lamb chops, that might be something else, but we can make fabrics cheaper than woolen fabrics today which can perform functionally just as well, perhaps even wool blends, and with the same margin of profit or lower relative margin of profit that there is in woolen fabrics, at a much lower price.

The ultimate answer will rest on just how low wool can go, that is, the price of raw wool, compared to the fibers with which we work. There is a tremendous difference between the lowest price of viscose and acetate compared to that of wool.

Although the newest fibers are all in the range of \$1.85, we believe that most of them will come down to \$1.25. Mr. Bendigo has given you an indication that they also will come down in price possibly toward the 40- or 50-cent level.

N. Leonard Jarvis: I don't wish to be too personal, but I am still curious to know how much a suit like the one you are wearing would cost? What does it cost in the shop?

Mr. Spiro: Some of you read in the news, I see, that Klein's has fire sales of anywhere from \$12 to \$14 close-outs. The fabric that I am wearing particularly, although it is strictly an experimental fabric—and I would like to make that clearly understood—would cost somewhere in the neighborhood of possibly \$1.80 to \$2 a yard today; whereas, a comparable 100% woolen fabric of equal weight, and I think of not such good performance characteristics, might cost somewhere in the neighborhood of \$3.50 a yard.

As far as the suit itself goes, the variable there is the manufacturer's cost and price that he wishes to place on the garment. But, judging by the difference of \$1.50 a yard in price of fabric or \$2 a yard in price of fabric and the same given maker—there are usually about 4 yards or 3½ yards in a man's suit—that would translate itself into anywhere from \$6 to \$8 in the cost of the fabric itself. That might result in a difference of anywhere from \$10 to \$15 in the price of the suit.

Question: Give us the total cost of the suit. Give us the retail value. What is its market price?

Mr. Spiro: These types of fabrics might sell in Crawford or Bond stores in the high twenties or the low thirties, against a woolen suit that might sell for \$8 or \$10 more, depending on the make again.

Without offering any plugs to Witty Brothers, they might get \$15 or \$20 more for the same type of fabric in a garment of a little better make.

Chairman Miller: Dr. Tesi has an additional point to make.

Dr. Tesi: This is a little embarrassing, since the fabric in my suit does not happen to be made by Robbins Mills. But I can be a little more specific. This is a suit that was made, I think, of about 50% acetate and 50% viscose. Although I don't pretend to be one of the ten well-dressed men in America, I feel that it is quite satisfactory. This suit was \$39.50. (Applause)

Mr. Spiro: He was robbed.

Chairman Miller: You are not on sale. I can tell you they won't even trade them, even though they tell you that their average is much cheaper. They won't trade them.

Lawrence Davis: I recall reading an article earlier this year about the interlining of suits containing metallic flakes; they call it aluminum flakes. The warmth quality is supposed to exceed that of overcoats.

I wonder whether any of the gentlemen are in a position to comment about that type of lining.

Mr. Bendigo: Forgive me if I don't mention any specific brand names. You are referring to a metallic coating which is applied in a resin form on a fabric. It was developed by a concern in what was generally called the Middle West, and has had a great deal of promotion.

We now have some very accurate figures on its performance. Two layers of such fabric with a dead air space between under perfect conditions will reflect one type of heat 15%. A single layer will reflect the same type of heat 5%. In other words, I am saying that the amount of the additional heat that you get from such a fabric is very, very small.

Dr. Tesi: Papers have been published and people have reported on this, so that there is no argument about it. One of the catches in a thing of this type is that, if you can keep the fabrics from touching each other, then you can get this 15% heat. But in actual use that is very difficult to do.

You would have to hold the thing apart by means of some sort of cross members, and that is quite hard to do in actual practice. So, the same thing that Mr. Bendigo said applies here.

Lawrence Ferguson: Dr. Tesi's Table 2 lists nine general types of man-made fibers. I think someone here mentioned that there might be 70 or 90 types, or some such figure. Could you give us the names and characteristics of two or three or four of the more important of those not given in this table?

Mr. Bendigo: Actually, most of the various types are variations within the ones that are on the table. The 70 will include the foreign fibers that are available in the United States.

Let's take viscose, for example. We have three tenacities—at least two that are generally known: the regular tenacity, the medium, and the high.

We have it in viscose, acetate, cellulose, viscose cuprammonium. We have it in continuous filament form and in staple form.

We have a lot of fiber variations such as Fiber E, which is chemically crimped and doesn't appear until the final finish.

Take nylon alone, which appears in regular tenacity and in high tenacity in continuous filament and in staple. As I said, they are fibers that can be identified in a fabric by a technician. If you want a complete listing, I will give it to you, but there are over 70.

Frank is pointing out that commercially, of course, there are not 70 that are significant.

Mr. Ferguson: I was thinking of different chemical forms as the difference between nylon and cellulose acetate.

Mr. Bendigo: I could give you a breakdown of the differences in chemical form, but there are larger differences in physical forms and in performance.

Oliver Grace: On the same line of questioning, is there a casein fiber that one of the leading milk companies put out in the United States? Was it Borden's?

Mr. Bendigo: You are probably referring to Aralac, produced by the National Dairies at a plant in Connecticut. Four units in a plant capacity of about 10 million pounds a year. That is a plant that was, I won't say exactly, abandoned, but the production was stopped. Then, later on, Virginia and Carolina took it over. That is the same plant where Vicara is being produced. Aralac is probably what you have in mind.

Question: Dr. Tesi, would you comment on the so-called direct spinning of acetate fiber?

Dr. Tesi: You mean, the direct coloring?

Question: Rupturing of the—

Dr. Tesi: The direct spinning.

Mr. Bendigo: I think you are referring to the time they take yarn of about 2,200 denier. There are two systems. One is a concern in the South. One is manufactured by Lowell. The operation is merely one of taking this entire cord-type of yarn, drawing it between rolls, blacking it, at the same time grafting it and spinning it all in one operation.

That gives you a type of fiber, or I should say a type of yarn, that is midway between continuous filament and spun types.

The principal drawback—or at least I thought it was a drawback—is that it has a residual shrinkage. Since the fibers are extended during the drawing operation and then later in fabric form, they tend to return. However, for at least one military use, that has been put to good advantage.

We do not foresee it as being of major importance or as competing with, shall we say, the conventional systems of spinning. The one that has the biggest possibilities is the so-called toe top, where you take your soft top, cut it up and spin it into yarn, by-passing this stage where the fibers are in a state of confusion.

Chairman Miller: Thank you, and thank you all very much.

Rockwell Report



by W. F. ROCKWELL, JR.

President

Rockwell Manufacturing Company

EVERY YEAR, at annual report time, we face the problem of what to include beyond bare financial figures. A business isn't just a name, a balance sheet, or products. Its corporate personality and health are influenced by many things—people, tradition, geography, management philosophy, competitors, "the times," changing markets, and dozens of other factors, often including luck.

A few years ago the Rockwell Manufacturing Company was a pretty small business. Compared to many American corporations, it still is, although its growth has been very rapid. It's our plan, through a series of informal advertisements, of which this is the first, to make the steadily increasing number of customers, employees, stockholders and suppliers better acquainted with the Rockwell Manufacturing Company by putting into the record some of the interesting incidents which shape a Company's personality.

* * *

Once a second, for over 20 years, a battery of our Nordstrom valves has been turned off and on by the action of arms attached to gasmeters in the Union Oil Company's plant in Santa Barbara County, Calif. The valves originally installed were a constant source of trouble because they had no lubrication. The Nordstrom lubricated plug valves installed as replacements are still on duty more than 20 years or 600,000,000 operations later.

* * *

Even as the manufacturer, we're often surprised at the ingenious, time-and-cost-saving applications customers find for our Delta power tools. Here's a few recently reported from Wisconsin: Racine Pattern Works got tired of wrestling heavy bath-tub castings around for machining, so a Delta 17" drill press was mounted on a slide to move the machine along the fork to drill the flanges. The Wisconsin Motor Corporation mounted eight 14" Delta drill presses in a single set-up to simultaneously drill 8 smoke holes in 3,080 aluminum pistons each 8-hour day. The Heil Company mounted eight 17" Delta drill presses with two-, three- and five-spindle heads to drill 19 holes on five surfaces of a shallow-well pump housing in a single set up. The Delta sales department in Milwaukee has collected hundreds of case histories of successful special set-ups as a guide to production men with a problem of their own.

* * *

Uncle Sam gets all that's coming to him when you slide your money across the bar for a glass of beer. That's due to a 270-pound hunk of bronze machinery, called a beer meter, of which there is at least one in every brewery. Periodically tested by the Bureau of Standards for the Internal Revenue Department, they account for about \$800,000,000 a year in taxes. Beer meters are another of our diverse products.

* * *

In acquiring eight companies in the last ten years we've been more interested in buying management than plants and tools. While we have a headquarters staff with specialized abilities in all phases of business operation, it is an advisory staff. The individual plant manager has the authority and responsibility to run his operation as if it was his own business—which in some cases it once was. Actually, therefore, the Rockwell Manufacturing Company is simply a group of small businesses, each locally managed, each a part of its own community, and each successful in itself.

First of a series of informal reports on the operation and growth of the

ROCKWELL MANUFACTURING COMPANY

PITTSBURGH 8, PA.



Avisco® AMERICAN VISCOSE CORPORATION

Dividend Notice

Directors of the American Viscose Corporation at their regular meeting on January 2, 1952, declared the regular dividend of one dollar and twenty-five cents (\$1.25) per share on the five percent (5%) cumulative preferred stock payable on February 1, 1952 to shareholders of record at the close of business on January 16, 1952. The directors also declared a dividend of fifty cents (50¢) per share on the common stock payable on March 3, 1952, to shareholders of record on February 18, 1952.

The payment of the common stock dividend was deferred until March 3, 1952 as the Corporation is advised that the retention of the dividend funds for a 60 day period after the first of the year will result in substantial tax savings. The dividend on the preferred stock, being on a different basis, was not deferred.

WILLIAM H. BROWN
Secretary



Southern California Edison Company

DIVIDENDS

COMMON DIVIDEND NO. 168

PREFERENCE STOCK
4.48% CONVERTIBLE SERIES
DIVIDEND NO. 19

PREFERENCE STOCK
4.56% CONVERTIBLE SERIES
DIVIDEND NO. 15

The Board of Directors has authorized the payment of the following quarterly dividends:

50 cents per share on the Common Stock;

28 cents per share on the Preference Stock, 4.48% Convertible Series;

28½ cents per share on the Preference Stock, 4.56% Convertible Series.

The above dividends are payable January 31, 1952, to stockholders of record January 5, 1952. Checks will be mailed from the Company's office in Los Angeles, January 31, 1952.

P. C. HALE, Treasurer

December 21, 1951

Industrial Controls and Servomechanisms

THURSDAY AFTERNOON, NOVEMBER 8, 1951

GERSON D. LUBLIN, chairman, presiding.
Chairman Lublin: Gentlemen, our subject is a timely one since the field is growing by rapid strides, and completely new vistas of application are opening up, for both military and industrial purposes.

Our first speaker is Mr. Donald S. Kellogg, chief engineer of the W. L. Maxson Corporation, which is now engaged in a large amount of both research and development, as well as direct production, in the electronics control field.

Mr. Kellogg, a Columbia graduate, with graduate degrees in electrical engineering received in 1937 and 1938, is particularly well qualified to describe what is meant by the fields we are surveying today, and, specifically, what the engineer means when he talks of a "servomechanism." It gives me great pleasure to introduce Mr. Kellogg. (*Applause*)

* * *

D. S. Kellogg: Mr. Chairman, ladies and gentlemen: When I was first approached to make a presentation, I was a little apprehensive. I thought of guards, signing passes, badges, putting things in double envelopes, and things of that nature. I thought of not talking in public places.

I thought of all those things because that is what "security" means. I was greatly relieved to find that our security system was not going to be analyzed.

You are about to hear an engineer's idea of what a security analyst would like to know about control systems in servomechanisms. We shall begin with a few basic examples, and then survey the present status of the industry and take a few looks into the future.

SOME FAMILIAR EXAMPLES OF CONTROL SYSTEMS

It seems appropriate in discussing the subject of control systems in industry to answer the question: Just what do we mean by a control system? We can start with something with which we are all familiar. Let us examine what happens when we drive a car. There is a part of our brain which decides where we want the car to go, our eyes observe where the car is going, and another part of the brain observes the difference between where we want to go and where we are going. If any difference exists, the brain sends impulses to the muscles in our arms causing us to steer the car and bring it back on its course. This is a very good example of what engineers call a *control system*. We refer to the cycle of brain to muscles to steering the car and back to the eyes and brain as a *loop*.

We all know what happens when the brain becomes too sluggish as a result of a few drinks. The brain's reaction time is slowed down with the result that the car swerves more or less violently from one side of the road to the other. This is what is known as an *oscillation* and is as undesirable in a control system as it is in the drunken

driver. Excessive time lags and poor measurements of the difference between what should be and what is are responsible for poor system performance.

OPEN LOOPS AND CLOSED LOOPS

In control system terminology, we speak of *open loops* and *closed loops*. Let us assume that we are driving the car and wish to maintain a certain specified speed, say, 30 miles per hour. We can look at the speedometer and regulate our foot on the accelerator to maintain this speed constant. As the car begins to climb a hill, we will find it necessary to press harder on the accelerator in order for the car to take on the additional load without slowing down. This is a *closed-loop* control system just as steering the car was a closed-loop control system. Now let us assume that the speedometer dial is covered so that we cannot see it. The loop is now open. We have learned to depress the accelerator a certain amount with our foot in order to get 30 miles per hour. However, now, when the car starts to climb the hill, we have no way of knowing that the car is slowing down; that is, we have no information fed back, and the car will not maintain its 30 miles per hour velocity. We speak of such a control system as "open loop" because the output information is not fed back to cause a correction. The open-loop control system is obviously far inferior in performance to the closed-loop control system.

EXAMPLE OF POOR CONTROL SYSTEM

If I said that the control of our economic system by the Government, as we know it today, is an example of a poor control system, I am sure you might agree with me for a number of reasons. Speaking strictly, from a technical point of view, we can observe a very sluggish reaction time to any changes that are introduced, and great difficulty is experienced in measuring results so that corrective steps can be taken in time. This is somewhat like the drunken driver, and the system oscillates more or less violently, producing periods of prosperity and periods of depression. If correct anticipation could be introduced so that we could measure trends and take corrective action before things got too far out of control, we could prevent the system from oscillating. Whether or not this is feasible is beyond the scope of this talk. In all control systems, the principle of introducing means for anticipating changes is basic for stable operation.

We can readily think of several other control system examples to help us understand just what we mean by this term. The thermostatic regulation of temperature in the home is one example. We give the control system an order by setting the temperature at which we desire the room to be held. The thermostat measures the difference between the order we have given the system and the actual room temperature, and, if the room is colder than what is desired, an electric contact closes and causes a circulating pump to

circulate hot water to the radiators. When the temperature reaches the place where it is supposed to be, the error-measuring device shuts it off. Here we can see most of the elements of a control system. Since there is usually no provision for cooling, this system can maintain uniform temperature only when the outside temperature is lower than the desired room temperature.

OTHER EXAMPLES

The pointing of a large gun or the automatic positioning of a machine tool cutter are other examples of control systems. In either case an order is set into the system. Let us say that the gun should point at an angle of 30 degrees relative to a reference position. A measurement is made of the difference between the place where the gun is pointing and where it is desired that it be pointed. This error is amplified and actuates a motor which moves the gun to its desired position. The term *servo* is often used to describe this type of system. Servo is derived from the Greek word meaning "slave," and we can say that a servo system is a slave system or a control system that follows orders. We also speak of *servomechanisms* and *servomotors* as important parts of control systems.

COMPUTERS AS CONTROL SYSTEM DEVICES

The newspapers have given a great deal of publicity to electronic computing machines, which they sometimes call electronic brains. There are many other types of computers, which perform their assigned tasks perhaps less spectacularly but just as effectively. Computers are often important parts of a servo system. Consider the case of aiming the gun. Since it takes time for the projectile to reach the target, the gun cannot be aimed directly at the target but must lead the target by a certain angle which depends upon the angular rate at which the target is moving, the range of the target, the rate at which the range is changing, the effect of gravity, and the type of ammunition being fired. A computer is simply a device which solves a mathematical equation in a prescribed manner and produces an answer. Thus, if we feed the various factors just enumerated into a computer, we can then solve the equations for the necessary lead angles, and we will thereby correctly aim the gun.

We can see that computers are important parts of some control systems. In the chemical industry, for example, the quality of a product can be measured, and, by means of a computing device, the correct temperature, pressure, mixture of materials, and rates of flow can be controlled to maintain the quality at the desired level.

DEFINITION OF A CONTROL SYSTEM

To summarize, we might define a control system as an arrangement of devices for controlling a process or a physical condition in accordance with predetermined requirements. The basic portions of a typical control system are an error-measuring device, a device for amplifying the error, a device for computing any predetermined relations that must be maintained, an actuating device or motor, an output-measuring device and means for feeding back the output so that it can be compared with the order to the control system.

TYPES OF CONTROL SYSTEMS

At the present time, a wide variety of control devices is available. We can find examples that operate on electrical, mechanical, hydraulic, electronic, electromagnetic, and pneumatic principles, to mention just a few. It is probably safe to say that every known physical law has been systematically explored for possible adaptation to a control system component. Some have proved more successful and reliable than others. Control devices are usually flexible in that they can be used in combination with one another in a variety of ways. Often there are many possible answers to what type of control system device should be used. Error-measuring devices seem to be predominantly electric, electromagnetic, or mechanical. Amplifying devices are predominantly electronic or hydraulic. Computers are predominantly electronic, electric, or mechanical. Servoactuators, or motors, are predominantly electric or hydraulic. Output-measuring devices are predominantly electric, electromagnetic, or electronic. This does not mean that there are not important exceptions to the above for certain specific applications.

DESIGN TRENDS

Present design and packaging of control system components are largely for special applications; however, there is a growing trend toward standardization of design for interchangeability and flexibility. The armed services are playing a leading part in bringing this about with their A-N and JAN standards. Military requirements for ready maintenance are leading to a unit or module type of design. Many control systems today have control devices which can be readily plugged in or removed from the system for replacement and repairs. The increasingly stringent requirements for space in military aircraft are leading us to miniaturization and subminiaturization of many of the system components.

SOME PRESENT-DAY CONTROL SYSTEMS AND THEIR PROBABLE SOURCE OF DEVELOPMENT

We might now examine some of today's commercial control systems to help us predict the trends of future control systems.

All major commercial airplanes are equipped with automatic pilots. An automatic pilot is a typical control system. It has a vertical gyro and a directional gyro, which establish the desired direction and altitude of the airplane. When the airplane tends to go off its direction or its altitude, the gyros measure the difference between the desired and actual conditions and feed signals to the amplifiers, which control servoactuators, which in turn operate on the control surfaces of the airplane. The airplane changes course or altitude or both as a result of reactions on the control surfaces, thereby reducing the error signals in the control system to zero.

THE CHEMICAL INDUSTRY

In the chemical industry, the manufacture of at least one commonly used material requires a very careful regulation of the mathematical relation among various factors during the chemical process in order that the material can be produced without dangerous explosions. It is only because

of the development of satisfactory computing devices which control the stability of this chemical process that such a process is commercially feasible today. Generally speaking, the chemical and petroleum industries rank high among today's major users of commercial control systems. There are many installations where accurate conditions of temperature, pressure, and rate of flow of materials must be precisely regulated to produce usable products.

CONTROL OF MACHINE TOOLS

We are also now beginning to see complete automatic control of machine tools, where a servo system positions the cutters in accordance with predetermined requirements set in on a roll chart or on an IBM-type punch card.

It is not difficult to trace nearly all of our present commercial control systems to a previous development for a military requirement. The very nature of the complex military problems involved in aiming guns, dropping bombs, navigating, and communicating, and the demand that they be solved rapidly and precisely constitute the whole heart of control system development. The impetus given to this development in the past ten or twelve years is tremendous. Private funds for research and development in some of our largest corporations are dwarfed by the Government outlay for armament. Thus, although private enterprise might eventually develop the needed equipment, technological advancement has been rapidly accelerated by the funds available in the military equipment industry. Since inventions developed for the Government for military applications are proprietary, insofar as commercial applications are concerned, there is a further strong inducement for expansion of activity. With this line of thinking as a clue, we can examine some of the present-day military applications which will find interpretation in the future commercial field.

LOOKING AHEAD IN THE CONTROL SYSTEM FIELD

We might consider radar navigation as an example. With a radar system, it is possible to observe in an airplane on a cathode-ray tube, similar to a television tube, a ground map of the territory over which the airplane is flying. This is possible regardless of visibility. It takes little imagination to envision the eventual development of a control system for an airplane that can automatically fly the airplane, using radar as a navigation basis.

DIGITAL AND ANALOGUE COMPUTERS

There has been a lot of publicity given to large digital and analogue computers such as ENIAC and REAC. These have been used for calculating anticipated performance of aircraft and guided missiles and can produce answers in a few seconds which would otherwise require the work of highly trained mathematicians and engineers for many months. There is already much talk about applying the principles of such machines in the business world to carry out such operations as accounting, payroll, and statistical analysis. Many business problems could be systematically analyzed in a manner that has never before been attempted because of the staggering amount of work that would be involved with present-day methods. This promises to open up an entire new field of business management.

The atomic energy industry will have a continually growing need for control devices and servomechanisms in handling dangerous materials. Such operations as weighing, pouring, and mixing can readily be done by the use of properly designed servo devices. Mass handling of such materials will similarly require a vast amount of process control equipment.

TRANSISTOR

A new type of device, known as a transistor, is currently being developed for military applications. The transistor has many amazing properties, one of which is that it can be used in place of some of our present-day electron tubes. Since it is considerably smaller and more rugged, it is likely that it will some day revolutionize the electronics industry.

BY-PRODUCTS OF MILITARY DEVELOPMENT

There are many by-products of military developments which find ready application in the business world. For example, the Maxson Corporation has been approached by a client who requires that the area under a curve on a recorded chart be calculated accurately and quickly. Many of these charts must be integrated every day for accounting and control purposes. At the present time, operators are required to do the work by a tedious process. By applying a recently developed chart-scanning technique which is being used in a control system computer for a military application, we are in a position to develop such a chart scanner readily without any substantial amount of additional research work.

In another case we are developing a highly accurate and flexible electronic means for measuring rates of flow of fluids and gases for a military requirement. The ready adaptability of such a device to the industrial processing industry is obvious.

SUMMARY AND CONCLUSIONS

To summarize our discussion, we have reviewed what a control system is and what it does, and we have tried to get a rough idea of how it does it. The tremendous scope and adaptability of the control system field has been implied. We have tried to point out how many of our present control systems have evolved directly from yesterday's military applications, and it appears that today's military developments are a key to many future possibilities. Some of these developments are immediately available, and others must wait for relaxation of security classifications. One thing is certain: We are on the verge of a great new industrial era, the automatic age, wherein the productivity of industry under proper conditions of enlightenment and incentive will soar to unprecedented heights.

It has been a great privilege for the W. L. Maxson Corporation to have participated in this forum, and it has been a great personal pleasure to have talked with you. Thank you. (*Applause*)

* * *

Chairman Lublin: Thank you very much, Mr. Kellogg.

Our next speaker, Mr. F. G. Cross, is a vice-president of the Robertshaw-Fulton Controls Company. Most of his attention is directed to the management of the Fulton-Syl-

phon Division, which specializes in bellows-activated types of controls. Mr. Cross is in charge of both sales engineering and management for this major division.

As a veteran of twenty-five years with Sylphon, the predecessor in a sense of Robertshaw-Fulton, Mr. Cross brings to bear on our discussion a rich background of experience and knowledge. Mr. Cross. (*Applause*)

* * *

F. G. Cross: Mr. Chairman, ladies and gentlemen: I am reminded of a comment a friend of mine made. He said, "Making any kind of a talk on controls is like having an addition in the family—easy to conceive, and hard to deliver." (*Laughter*)

The term controls or even industrial controls is so broad that it immediately becomes necessary to define and limit it for the purposes of practical discussion. Just as the word security in the title of your organization raises the question whether we mean national, internal, plant, social, or corporate security, the word controls covers the water front—not excluding the possibility of price controls and materials controls.

To get to the point quickly, then, my discussion covers temperature and pressure control, including their twin brothers for humidity and flow. This is the segment of the controls industry with which my own corporation, over about fifty years, and I, during the past twenty-five years, have been principally concerned.

In talking I shall steer clear of strictly technical details, and I shall not burden you with a mass of statistics. My companion speakers in the forum, Mr. Kellogg and Mr. Benedict, discussed several other controls categories. A question and answer period will follow, and Mr. Sam Eskin, our corporation's staff technical adviser, will have the answers to any technical questions on my discussion (I hope).

TYPES

There are three general categories of temperature and pressure controls, consisting, without regard to relative importance, of (1) electric, (2) pneumatic, and (3) self-operated. I believe it correct to state that all controls available now and in the foreseeable future fall into one or a combination of these categories.

Electric controls (including electronic) designate those using various kinds of electric circuits for operation of the control mechanisms—usually valves, switches, or dampers. The types of circuits vary from simple to complex depending on the nature of the results to be accomplished. Obviously, electric power is the prime source of energy—and is usually available.

Pneumatic controls are those in which compressed air is used to operate the control mechanisms—distributed to such mechanisms through small-diameter piping or copper tubing. Since the operating energy is compressed air, an air compressor is a necessary adjunct to such control systems.

Self-operated controls are those requiring no outside source of power for operation. In temperature controls, this power is obtained by subjecting the thermosensitive bulb, charged with proper materials, to the temperature of the controlled medium, which generates power for opera-

tion of the control mechanism, either by thermal expansion of the material or by vapor pressure when charged with liquids.

Various combinations of these three basic types are used when so indicated by the application. Time-interval controllers, indicating controllers, and recorder controllers, containing clock mechanisms, with automatic raising, lowering, and resetting of control points, are in common usage. Examples in our own homes are the combination time-temperature controllers on our gas and electric cooking ranges, automatic washing machine, and the clock thermostat on our house-heating system. There are many similar applications in industry.

THE INDUSTRY

I would like to give you a quick picture of the temperature and pressure-control industry. The manufacturers vary from small concerns making one or several highly specialized items by model shop methods to substantial highly integrated organizations serving mass markets with mass-production techniques. Because of the wide variety of applications and diversity of methods employed, the industry is a rather heterogeneous one, and there is no formal association embracing the entire industry. There are some associations, grouping some of the manufacturers in some segments of the control industry, such as industrial instrumentation—valves and regulators—refrigeration controls—but there are many companies in no industry association. As a result, no really valid statistics are available. A conservative estimate of annual sales is a minimum of one-half billion dollars—possibly three-quarters billion dollars.

COMMON CHARACTERISTICS

One common characteristic of the companies—large or small—is a high degree of uniqueness in some particular phase of control. For instance, one company may specialize entirely in refrigeration controls, another in industrial recorder controllers, a third in gas and electric cooking and water-heater controls, and still another in automotive controls.

Another characteristic of the industry is a wide diversification of the markets served, which in turn has resulted in corresponding diversification of controls items manufactured by the medium-sized and larger companies. This, of course, creates internal co-ordination problems, but, by the same token, provides a factor of business stability. By departmentalizing and providing specialists for the various industries served, this problem is solved in a practicable manner. Typical of the larger companies in this respect is my own corporation, serving the cooking and water-heater industries, automotive, refrigeration, heating, and air conditioning—and a wide variety of the process industries—as evidenced by the slogan: "Everything's under control." This slogan, incidentally, pretty well describes the control industry.

The personnel in the industry is, by its very nature, definitely on the technical side. There is a continuous influx of young engineering graduates—or their equivalent—into the industry as a whole, and these men gravitate into research, product development, application engineering, manufacturing, or sales, and eventually into management, accord-

ing to aptitudes and inclinations. In no industry, I believe, would a cross section of personnel show a more alert and capable group of young men. Parenthetically, it is my opinion that most, if not all, the technical contributions in controls have been made by the "young screwballs." Now that I have graduated into my fifties, it will be interesting to see if I continue in that opinion.

APPLICATIONS AND MARKETS

Controls have become such a universal factor in our individual day-to-day lives, as well as in industry, that we can mention only some of the more important applications and markets.

Automotive. The principal applications that have been supplied to date by the controls industry are engine thermostats and car-heater controls. Other controls problems are present, such as automatic choke, gaging, and metering—most of which are supplied by car manufacturers' subsidiaries or manufacturing specialists in these items.

Engine thermostats are used to control the engine-cooling system at the most efficient temperature by regulating the coolant flow to the radiator. They are now standard equipment on every automotive engine.

Car-heater controls are used to regulate the inside car air temperature during cold weather when the heater is operating. Although not yet standard equipment with all manufacturers, their use is growing, and they doubtless will be as commonly used as engine thermostats.

Projected new engine and car designs and additional accessory designs are creating additional possibilities for controls.

Distribution is direct to car manufacturers, and special automotive controls sales engineers are utilized for this high-volume market.

There is an additional market in distribution to the automotive replacement parts trade, by a different group of salesmen, of the merchandising type as distinct from the sales engineer type.

DOMESTIC APPLIANCES

There is a large and growing market for controls of domestic appliances of various kinds, such as we have in our own homes. Although materials shortages in the defense program have cut back a number of domestic appliances currently produced, this condition is temporary (barring all-out war), and, as materials become available, this market is expected to go forward with increased vigor.

Gas and Electric Cooking Stoves. The extension of natural gas and electricity, supplemented by bottled gas, have made a very active market for the controls which are essential components. Controls are standard equipment on all gas and electric stoves. After the current temporary lull, the demand is expected to continue to grow. My own corporation, which enjoys a substantial portion of this market, expects to continue to do so. You, or whoever does the cooking in your household, are familiar with these controls' functions.

Gas and Electric Water Heaters. The foregoing comments are equally applicable to the gas and electric water-heater applications and markets. Should there be any

doubt of the essentiality of water-heater controls, we have only to experience failure or damage to the water-heater control in our home to learn how it disrupts the household.

Gas and Electric Clothes Dryers. Here is a market requiring controls, which is a companion to the automatic washing machine. We look for a continuous increase in this market—for the housewife has begun to look upon the automatic washer and companion dryer as a combination as natural as ham and eggs. All the automatic dryers require controls—and the market is relatively in its infancy.

Automatic Washing Machines (Home Laundries). The cycle of washing, rinsing, and spin drying requires a combination of timer control, temperature control, and flow-metering control. Most of the washing machine manufacturers have development and expansion plans toward new designs and increased production capacity and at the same time are working toward cost reduction, which in my opinion, within the span of a few years will almost completely obsolete all but automatic-type washers. This market is an active one and will be increasingly so, for the controls manufacturers.

Distribution of controls in the domestic appliance market is direct to the appliance manufacturers, as original equipment, and is handled by controls sales engineers, who maintain close liaison with the engineering, production, purchasing, and service departments of the appliance manufacturer.

REFRIGERATION

This market, both domestic and commercial, has been very active and, except for the lull during materials shortages, is expected to continue so. The usual controls applications are thermostatic switches and expansion valves—with a recent new one for automatic defrosting, which will gain, eventually, universal use, in all probability. There is a field for a more satisfactory automatic defrosting control, and a number of controls manufacturers are exploring various methods.

Some of the larger refrigeration manufacturers make their own thermostatic switches and expansion valves and in those cases buy certain components from the controls manufacturers.

Distribution is direct to manufacturers as original equipment, although there is some distribution in the commercial field through refrigeration supply houses.

HEATING, VENTILATING, AND AIR CONDITIONING

Here there are many applications, and the market is interlocked with new building construction and modernization.

The applications with which you are probably most familiar are those in your home, involving primary temperature, pressure, and safety controls on your oil-, gas-, or coal-stoker-fired boilers or furnaces, and the room or zone thermostats for final control of living space temperatures. At anticipated rates of building construction and population growth, this market for domestic controls is an increasing one and highly competitive.

In the industrial and commercial building field, the ap-

plications are indeed varied because of the diversity of heating and air-conditioning systems used. These applications range from simple individual thermostatic radiator valves to complete systems of control, utilizing electric, pneumatic, self-operated—or combinations thereof.

As a matter of interest, there seems to be a trend toward heating and air-conditioning living and office spaces in sizable buildings by the use of hot water for heating and refrigerated water for cooling, both generated at a central station in the basement, and piped, together with pressurized air in small ducts, to individual room-conditioning units. A number of the larger air-conditioning manufacturers are now fostering this type system, which gives the room occupant individual selectivity of the temperature to be maintained. In addition to the usual control applications, this presents the controls industry with the further problem of developing a suitable economical automatic switchover device, built into the room temperature control, for automatically selecting the correct (that is, either heating or cooling) medium and rejecting the incorrect medium, during the fall and spring months when both hot and cold water are piped to the unit. It is now being accomplished, but a simpler more economical method is a must to avoid excessive cost.

SALES AND DISTRIBUTION CHANNELS

The sales and distribution channels in the heating, ventilating, and air-conditioning market are exactly like those in the domestic appliance field, for controls on oil-burning, gas-burning, or stoker-fired boilers and furnaces, and any individual packaged units—that is, direct to manufacturers as original equipment. However, for a building system, other than individual packaged units, it becomes necessary for the sales engineer to sell the consulting engineer who lays out the job to obtain acceptance in the specifications, the owner, the bidding contractors; to get his particular controls offered in as many bids as possible; and finally to obtain the order from the successful contractor. I can assure you that this process can sometimes be quite a merry-go-round.

TRANSPORTATION

I have already mentioned briefly the automotive market. The controls applications on railways and ships fall generally into three kinds: (1) Diesel engine control (control of engine cooling and lubricating oil temperatures, safety alarm controls on lubricating oil pressures), (2) refrigeration controls on some ships and freight cars, and (3) passenger space temperature controls and ventilation controls. The refrigeration and passenger space controls applications are similar to corresponding applications in buildings—except for one important point: The controls must be more ruggedly built than for stationary applications, to withstand vibration and shock.

The same type Diesel controls are used on stationary Diesels, in a steadily growing market.

Airplane control are quite specialized, and, with constantly changing engine and plane designs, accelerated by the defense program, the controls designs and applications are in a corresponding continuous state of change. The controls industry expects to play its part in this highly spe-

cialized field. I will not attempt to go into the intricate fire control and navigational control which are so necessary to military planes. This is a game in itself.

INDUSTRIAL PROCESSES

We now come to industrial process controls applications, and the numerous kinds of processes found in industry make this an exceptionally complex subject. I can only hope to give you a few high lights.

Industrial process controls may be roughly divided into two classes: (1) control valves and regulators, and (2) instrumentation. Both groups are highly essential to industry, all kinds of industry on process control. My own corporation has for years specialized in the control valve and regulator group. Other well-known companies have specialized in the instrumentation group. Included in the instrumentation group are indicators, recorders, and recorder controllers, for measuring, indicating, recording, and controlling. Control valves and regulators, as the name implies, comprise means for controlling, but without the afore-mentioned instrumentation. Industrial consumers purchasing control valves and regulators, can, of course, supplement with such separate indicating and recording instruments as are desired.

Developments in electronics during and since World War II have made practicable many refinements in the combinations of control valves and regulators with instrumentation, and greater ease of remote indication and recording of various steps in process control, at centrally located instrument panels. Aware of this trend, my own corporation for some time has been exploring the desirability and ways and means of entering this field. I am now glad to be able to state to this group that, as a result of research activities and acquisition, neither of which have been fully consummated, we expect, in the not too distant future, to have available electronic instrumentation, in addition to control valves and regulators, and to be able to offer the process industries the combination of control valves and regulators, with electronic instrumentation. We expect to do this gradually and are not yet ready to make formal announcement to industry.

The market for industrial process controls is a soundly growing one—and the controls industry expects it to continue to increase, as general industry modernizes and expands. It is a matter of record that, during World War II, Mr. Charles Wilson, then executive assistant to the War Production Board chairman, established the industrials controls industry as of highest essentiality, and saw to it in person that industrial control valves, regulators, and instruments were speedily made available for the war production program. During the present defense program, the industrial process segment of the controls industry has increased its business and will probably continue to do so as defense production expands.

Distribution of industrial process controls is through sales engineers—usually directly through the industrial plant. In some cases it is necessary for the sales engineer to contact a consulting engineer performing process layout for the plant, and assist him in an advisory capacity on the controls problems. In other cases (larger industries) he

performs the same function for the plant process engineer. In a sense, the sales engineer is, himself, a consultant on process controls. This segment of the industry, because of the sales and applications engineering required, operates at higher sales costs—but these services, figured in selling prices and profit margins are, in general, quite satisfactory.

CURRENT OPERATIONS OF CONTROLS MANUFACTURERS

Although materials shortages in some of the nondefense markets—especially the mass production markets—have acted as deterrents to the climb of sales curbs of controls manufacturers supplying those markets, most, if not all, of the manufacturers have sales at the end of the first three quarters this year in excess of the corresponding period last year and expect to finish this year with higher sales than they did in 1950. Unless, however, a company's sales volume has been upped very substantially by defense business, the higher taxes now obtaining result in lower net earnings after taxes. Although the controls industry has obtained defense contracts and subcontracts in substantial volume, in many cases the tooling-up period following materials cutbacks has caused a sales lag during the last half of the year. I believe it will be typical to expect 1951 sales to be somewhat higher and the net earnings after taxes to be somewhat lower than those of 1950.

FUTURE OUTLOOK FOR THE CONTROLS INDUSTRY

Following the leveling off of the defense program, the controls industry looks forward with confidence to a continuation of good and gradually increasing business—always provided, of course, that economic conditions are such that good general business obtains. The controls industry cuts across and is interlocked with general industry. It has expanded its facilities, has the personnel and the know-how, and, above all, has the strong desire to broaden its activities. Increasing mechanization in industry and home creates more applications and greater markets for controls. The peacetime possibilities of atomic energy alone constitute a challenge and, in all probability, a new and growing field for the controls industry. We think the controls industry has a bright future. And you may be assured that my own corporation will be in the front row. (*Applause*)

* * *

Chairman Lublin: Thank you, Mr. Cross.

I think that, if it is agreeable, we will take a five-minute recess. (*Recess*)

Chairman Lublin: Our last speaker, Mr. F. R. Benedict, is from Pittsburgh where he is assistant manager of the industrial products division of Westinghouse. Whereas Mr. Cross emphasized some of the smaller consumer uses of controls, Mr. Benedict will stress the larger items and permanent installation items.

He has been with Westinghouse for twenty-three years, I think. He has been in many phases of their operations. He is thoroughly familiar with the field. It gives me great pleasure to introduce Mr. F. R. Benedict. (*Applause*)

* * *

F. R. Benedict: Mr. Chairman, ladies and gentlemen: You have heard many confounding words this afternoon,

and I will probably add a few more. I hope you will keep the most select ones to confound your most intimate friends.

In this short space of time, I can give you no more than a brief look at some of the important industrial developments. In order to reduce cost and increase productivity, nearly every machine used in process manufacturing today is equipped with automatic or semiautomatic controls. The control portion of a drive would normally represent 5 to 10% of the total system—motors, control, process machine—cost. When the motors are included, the motor and control cost is seldom less than 20% of the total system cost.

Industrial controls will represent about \$125 million in 1951, and motors about a \$400 million market. You can see, therefore, that industrial controls are big business and that they deserve the highest recognition in our expanding economy.

Industry's trend toward higher process-line speeds, more precise control of the process, and more automatic machinery calls for more of what can be called system engineering. Several or many machines must be integrated, not only in operation but also in original design. The most commonly thought-of examples are the spectacular steel-rolling mills and paper-making machines. But system engineering is not confined to these colossal machines. Some seemingly small processes are requiring system engineering.

SYSTEM ENGINEERING WITH PACKAGE DRIVES

The control and drives for making (casting, it is called) Cellophane in sheet form from raw material is an example. The casting machine is driven by five motors, the largest being only 5 hp. But the speed requirements are rigid. The speeds of any one motor must not differ from those of any other by more than 0.1% (which is 1 rpm in 1,000), and the speed of the drive as a whole must not vary from a preselected base by more than 1%.

Power for such a drive is supplied and regulated by a specially designed 15-hp packaged drive, which consists of a motor-generator set with electronic regulators and controls for the five individual motors, all in one cabinet. The cabinet drive also contains a Rototrol rotating regulator to control the wind-up reel, whose motor speed must vary exactly in accordance with the buildup of Cellophane on the reel. The entire drive was designed as a unit, assembled, tested, and shipped as such. Installation consists of setting in a prepared location and connecting ingoing and outgoing leads. No alignment or combination testing, on the site, of parts of different origins is required. No foundations are necessary. Space occupied on the manufacturing floor is very little.

A representative new use for packaged drives is to drive the Gisholt Dynetric Balancing machine. Current limit control is used to limit the torque transmitted through a delicate coupling for obtaining maximum acceleration and deceleration without damage to the coupling. The use of the packaged drive with current limit control results in greatly reduced costs over regulating systems previously used.

Larger Packaged Drives. Packaged drives have grown steadily in size. When they were introduced years ago, the

largest was approximately 25 hp. Now standard packaged drives are available in six cabinet sizes for capacities up to 200 hp.

When precise voltage regulation or pushbutton station controls are required, electronic tubes provide the excitation. When these or other special requirements are not called for, a simpler excitation employing selenium rectifiers is employed.

FIBER MAKING CALLS FOR SYSTEM ENGINEERING

As an example of the careful integration of many machines and their controls of modern manufacturing processes, we have the preparation of synthetic fiber (Orlon). The filaments are formed by forcing the raw material, a liquid, through orifices. This is done by 112 fractional-horsepower synchronous motors that drive constant-pressure pumps. Power is supplied to these pump motors from a common motor-generator set of the AV type. It is imperative that pressure be maintained constant at all speeds and regardless of how many three sections of the machine are running.

The filaments are fed into a curing chamber in which are also 112 feed wheels or capstans, individually driven by synchronous motors supplied from another motor-generator set. The denier of the synthetic thread is set by the relationship between the pump motors and the feed-wheel motors. This must be maintained with great exactitude and is accomplished with electronic regulators that hold speed to 0.1%.

The finished thread is wound on 14 drum-type winders, individually driven by reluctance-type synchronous motors. These must start an empty reel, wind up the thread coming to it at better than a mile a minute, with declining reel speed as the reel fills, and finally stop to allow full-reel removal, all without any effect reflecting into the previous sections.

MAGAMP ROLLING MILL CONTROL

The magnetic amplifier—Magamp as it is called—has been known and used for years. Basically the device is employed to secure amplification through saturable reactors, either alone or in combination with other circuit elements. The first applications involved the use of simple saturable reactors in which the reactor impedance was varied by circulating direct current through a separate winding and thereby saturating the core material. By this means the amount of a-c power supplied to, say, a resistance-type electric furnace could be controlled by the d-c excitation of a saturable reactor. Relatively large amounts of a-c power could be controlled by small amounts of d-c power.

The power amplification obtained in this way, however, was not exceptional. The first major advance came with the discovery of the principle of self-saturation. When saturable reactors were used in combination with rectifier elements and only unidirectional current allowed to flow in the output winding, it became no longer necessary for the control excitation to counteract the magnetomotive force established by the output current. The control excitation could be fully used for saturating the core material. The performance of self-saturating magnetic amplifiers was greatly improved by the development and use of high-per-

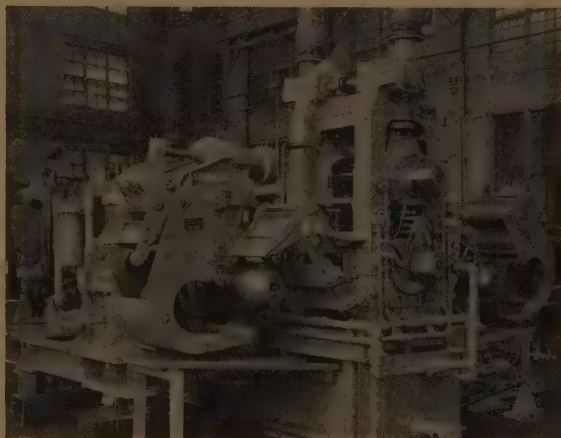
meability core materials, such as Permenorm 5000Z and Hipernik V and improved rectifier elements such as selenium and germanium crystals.

With these developments much larger power amplifications could be obtained, but the potentialities of the device were not fully realized until the development of automatic feedback control systems. These systems required the use of amplifying devices, and the advantages of the magnetic amplifier as compared with rotating and electronic amplifiers soon became apparent. By providing a multitude of control windings, signals can be added or subtracted in the same manner as is presently done with the Rototrol. Consequently, regulating systems involving the use of Magamp are similar to those involving the use of Rototrols.

Today the steel industry is using more automatic regulating equipment on drive systems than ever before. This has been a result of increase in operating speeds, continuous striving for better quality, the demand for greater tonnages from existing facilities, and the need for eliminating the human factor in the application of production processes. Thus, the need has arisen for a static, rugged, simple, and maintenance-free amplifying device for regulating systems. The Magamp satisfies these requirements. It is an entirely static device; it can withstand shock and vibration; it is relatively simple and will operate with little maintenance over an indefinitely long lifetime.

PACKAGED POWER PLANTS FOR ROLLING MILLS

Even rolling mills are packaged as units now (Figure 1). It is possible for a product manufacturer to purchase a small, single-stand mill to roll metal to his particular requirements, starting with standard available sheet, or strip. The power supply for such a mill comes packaged too. In a single metal cabinet 61/3 feet high, 81/3 feet long, and 31/3 feet deep, is a 75-hp motor-generator set to supply power to the main and reel motors, a small booster motor-generator set to provide IR drop compensation for the reel motor and to improve regulation, and all the control apparatus. The unit is, in effect, a variation of the AV drive idea. The power plant uses a selenium



United Engineering and Foundry Company

Figure 1. Packaged Power Plants for Rolling Mills

rectifier to supply excitation (eliminating one rotating machine). It also uses a magnetic amplifier as a current regulator for the reel motor to enable it to maintain constant tension as the strip builds up on the reel.

The complete power plant is assembled and tested at the factory and shipped as a unit. All parts are in their normal positions, and for installation the unit is set on a prepared foundation, and electric connections are made.

REMOTE-CONTROLLED INGOT BUGGIES

If one were to visit a steel mill in Ashland, Ky., he might witness a sight that suggests the day of the automatic factory is at hand.

He would see an ingot car on rails with no operator in sight. This car suddenly comes to life, moves along its track, and stops before one of many soaking pits. A waiting crane deposits a white-hot ingot on it. Without apparent further direction, the ingot buggy proceeds along the track and unloads itself onto the tables before the mill stands. The buggy may thereupon wait, as if for some further invisible order, or it may return again at once to a different pit location for another ingot.

The performance is not, of course, so mysterious as it sounds. It is a manifestation of remote control.

The man who runs this show is the operator of the ingot crane. In fact, it is either of two crane operators. To load the buggy, one of the cranes takes a position over the pit with the waiting ingot. The crane operator then presses a button, and the buggy comes to that position beneath him and stops. When the buggy is loaded, the operator presses another button, and the buggy departs to the discharge position, whereupon it goes through a sequence of unloading operations, all automatically and all sequence-interlocked for safety. The crane may meanwhile take up a new position, and the empty buggy will obediently follow it to that spot, or the operator may release the buggy to a waiting period, to be recalled when needed by either crane.

Key to this control are two parallel and cemented trolleys. One is contacted by the crane in its travel; the other, with matching segments, provides the buggy control. The two trolleys form two sides of a bridge circuit. When the crane and the buggy are in different locations, an unbalanced current flows. This current causes the buggy to travel along its track until the unbalance disappears. To cause the loaded buggy to move to the discharge end, the control makes it appear to the buggy that the crane has suddenly moved to that location.

A somewhat similar scheme is also being applied to an ingot buggy pulled back and forth by a cable, instead of under its own power. With this system an operator at the unloading end controls all the movements of the buggy. He can cause it to move to any one of eight soaking-pit locations and to the delivery terminal. This action furthermore must be done at a high speed (only 58 seconds are allowed for a round trip, requiring a top speed of 1,200 fpm) and the car must be spotted within narrow limits.

The control has many additional novel features. It can detect a broken cable, and it is arranged for simple compensation of cable stretch during use—which may be two or three times the allowed variation in spotting. The oper-

ator does not need to use the buggy; its position is shown to him at all times on a dial.

ORE BRIDGES GO TO ADJUSTABLE VOLTAGE

New ore bridges and unloading towers used to handle iron ore at points of transshipment or at steel-mill storage points are adopting adjustable-voltage drives. Alternating-current power is transmitted at high voltage (4,160 volts) to the bridge, which carries its own conversion equipment. The system closely resembles that used to power electric shovels. One a-c motor is used to drive several adjustable-voltage d-c generators, one for each motion of the bridge and its bucket. This system combines the advantages of high-voltage power distribution with the unexcelled performance of adjustable voltage, and mill-type d-c motors.

The first ore bridge to employ this system went into service last year at the Otis Works of the Jones & Laughlin Steel Corporation. This bridge has a 17-ton bucket that can unload ore boats to the storage pile or fill charging cars from storage. Other ore bridges are now being built to use this system.

HELP IN REMOVING BARK FROM LOGS

The removal of bark from a giant log with water jets is a spectacular sight. By one of the hydraulic-jet methods, an operator "tools" the bark of a horizontal rotating log by playing across it a jet of water at tremendous pressure. In a few seconds the bark is ripped from a log 30 feet long and 7 or 8 feet in diameter, leaving it starkly bare.

The controls that have been provided for the operator have usually consisted of four levers—for adjustable-speed rotation of the log and horizontal sweep of the jet in each direction—and pushbuttons in the lever handles for control of log unloading and loading mechanisms and other functions. To manipulate the many controls—and the average big log is denuded of bark in less than a minute total elapsed time—the operator is busier than the traditional one-armed paper hanger. A pipe organist would be a better comparison.

To simplify the controls and to reduce the movement and effort of manipulating the levers and buttons that, in several hours, amount to fatigue, a control of entirely new type has been developed. The control of all actions is resolved into a single device that resembles an airplane control wheel. It is, in fact, an airplane control wheel, for the original idea came to the plant engineer of the Crown Zellerbach Corporation when he rescued from a near-by river the wheel of an airplane that had crashed. It was his idea that, much like the operation of flying an airplane, right-hand rotation of the control wheel would cause variable-speed rotation of main trunnions and the log in the right-hand direction, and left-hand rotation of the wheel would produce left-hand variable-speed rotation. When the wheel was pushed forward, the hydraulic barking nozzle would traverse the log away from the barkerman at a speed proportional to the forward movement of the wheel. Likewise, pulling the wheel back toward the barkerman would produce opposite direction of movement of the nozzle, with speeds proportional to the backward displacement. All four motions as described were to be incorporated on the wheel; in addition two conveniently located thumb push-



Figure 2. The Gulf Pipe Line Control

buttons would control the loading and unloading operations. A requirement of the controller was that the airplane wheel would return all controls to the central or "off" position whenever the barkerman lifted his hand from the wheel. Also, the wheel was to be easily operated in all directions of travel.

The movements of the wheel are transmitted to small push rods of four separate Silverstat contacting resistor elements. The changes in current produced by these Silverstat elements, in turn, produce the required current variation on the pattern fields of Rototrol exciters. The Rototrols then excite the main propulsion generators to produce the desired directions and speeds of operation.

HELPING MEET THE DEMAND FOR FUEL

The fastest growing transportation system lies underground. Pipe lines are increasing fabulously, both in length and in size. In the five years, 1946-50, about 46,000 miles of trunk petroleum and gas line have been laid in the United States alone, and 12,000 more are in the construction or planning stage. As of 1950, the world had about 450,000 miles of pipe line (gathering and trunk), equal to 20 times around the earth. Pipe diameters are increasing. The famous Big Inch (24 inches) line of World War fame is no longer the big line. One half of a 550-mile crude oil line to be built to tap the West Texas field by the West Texas Gulf Pipe Line Company will be 26 inches in diameter. Still larger is the Trans-Arabian line built of 30- and 31-inch pipe (nesting one inside the other to save shipping space). An even larger pipe is the 34-inch natural gas line in California.

The Gulf Pipe Line. The various pipe lines abound with interesting new technical features. The Gulf pipe line, for example, will feature the largest concentration of remote tank-farm pump and manifold valve controls thus far centralized on a control console (Figure 2). On one console will be the control of more than 100 valves and 11 booster pumps. Initially this line will have three pumping stations with 24,000 hp in main-line motor-driven pumps, giving a daily capacity of 300,000 bbl. Booster stations to be added later will raise this to 440,000.

The Plantation Pipe Line. One of the most famous pipe lines, the 1,261-mile products line of the Plantation Pipe Line Company, built from Louisiana to North Carolina in 1941, has been "double-tracked." The original line was 12 and 10 inches in diameter. On the same right-of-way with

it has been laid an 18- and 14-inch line. The same pumping stations, greatly expanded, are used.

The new Plantation line uses a novel way of measuring pressures. At the various pump locations, pressures are measured by Baldwin strain gages. The indications are amplified and transmitted as electric signals to the control room. Previously this has been done by carrying the refined petroleum in small pipes to the console. Although the constructions with this direct method of measurement have been designed with large safety factors, the presence of flammable products lines in the control room does introduce a hazard. Also the small-size pressure pipes sometime corrode to the point of plugging up. The strain gage method is no cheaper, but does establish station conditions highly attractive to pipe line operators.

Trans-Arabian Pipe Line. Electrifying pumping stations in the Arabian desert involves more than it does elsewhere. Electrification of the Trans-Arabian stations actually is only one part of the job. The six stations motivating this system average about 165 miles apart across a flat, treeless, arid region, without intervening habitations, verging at the western end into a mountainous, sparsely settled terrain. Each station must be made a self-sufficient community. Thus the stations, in addition to housing the pumps, become the heart of a small town and provide the services for it. This includes power plants for all electric power and for lighting, for air conditioning, for pumping of the precious water supply, and even for the theater and other services necessary to make life pleasant in such isolated areas.

The pumps themselves are engine-driven. However, new controls have been built so that pumping operations are handled from a modern, centralized control console in essentially the same way as at the motor-driven stations in the United States.

Supervisory Control and Microwave. The men who are in the business of transporting gas and oil in pipe lines have taken a leaf from the book of those who transport kilowatts. This is the control of remote apparatus using supervisory control equipment. A booster pumping station and a main-line valve of the Pan American Pipeline in Texas will be controlled entirely by an operator in a station 40 and 80 miles away, respectively. The supervisory control system is basically the same as that used by electric-power companies for years, but the equipment has been modified to be in keeping with pipe line practice. Signals will be interchanged between the control and the controlled stations over a microwave system previously installed for communication purposes. The attendant at the master station will be able to operate all suction and discharge valves at the distant stations, can start and stop each of two pump motors, and can perform other necessary functions. The control also gives him, automatically, several indications of the state of affairs at the two unattended points, even including the presence of hazardous gas in the station buildings, and any abnormal pressures or bearing temperatures. Various pressures and motor currents are telemetered to him continuously. The supervisory control apparatus even checks itself and the circuit, and, if it should become inoperative for any reason, it "says" so. To perform any of the desired operations by

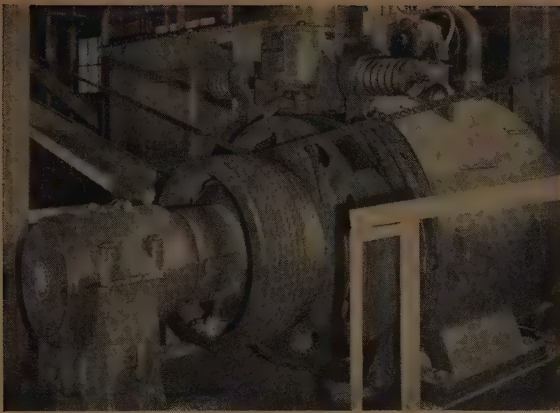


Figure 3. For Better Sawing—Log Carriage Control

the supervisory apparatus, the operator presses buttons exactly as if the equipment were in the next room. All selection and checking of communication circuits is done automatically.

FOR BETTER SAWING

One of the most spectacular industrial operations is the sawing of huge logs into lumber. The log, if it be a Douglas fir in the Pacific Northwest, may be up to 8 feet in diameter and 30 feet long and weigh 20 tons. It is placed on a log carriage, which shuttles back and forth before the continuously running bandsaw, under the sawyer's control. The sawyer's job is one requiring great skill, for it is one of judging each log and making rapid decisions as to what sizes and shapes of stock to make out of the log, so that



Figure 4. Tin Plate Faster

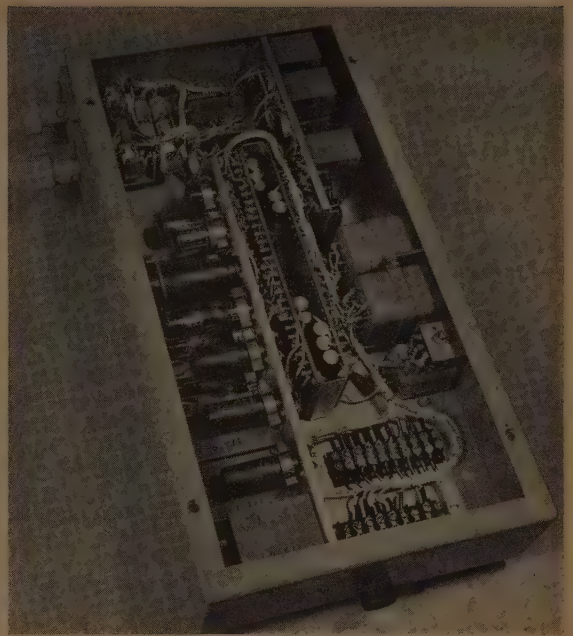


Figure 5. An Electric Regulator for Steam Turbine

the total value of the product will be the largest possible. He follows his decisions by signaling his carriage-borne assistant or assistants in a sign language peculiar to his trade and by appropriately manipulating the carriage drive control. Anything that can be done to reduce the physical effort involved in these manipulations will quite naturally reduce the sawyer's fatigue and enable him to do a better job, resulting in a more profitable use of his raw material.

Two amplifying devices were paired last year to do this (Figure 3). They are the Rototrol and magnetic amplifier. Together, they permit control of the powerful output of the adjustable voltage d-c log carriage drive from a small, very low-effort sawyer's master switch. This combination gives the sawyer, almost literally, finger-tip control of carriage movements. Any speed from maximum to zero and to maximum in the reverse direction is obtained by movement of the master switch handle through a travel of only 11 inches and a force never exceeding the weight of a man's hand. The switch itself incorporates a slight modification of the series of metal leaves with silver contacts, such as are used in the Silverstat regulator. Successive closures of contacts are made by applying an increasing pressure to the outer leaf. The resulting small changes in current are built up by the combined amplification of the magnetic amplifier and Rototrol, and applied to the field of the drive generator where it acts to control drive speed. By means of feedback in the system, accelerating rates are automatically limited to safe values, and running speeds are held constant.

TIN PLATE FASTER

Radio-frequency energy continues to receive the nod as the means of reflowing tin when tin plate is made by the



Hare Photographs, Buffalo

Figure 6. Crane Control—Load-o-matic

electrolytic process. Late in 1951 a new tinning line placed in service by Jones & Laughlin Steel Corporation at its Aliquippa, Pa., plant set a new record for speed. It produces tin plate at a nominal speed of 2,000 fpm, a little more than 10% faster than previous lines (Figure 4). To provide the desired hard, high-shine surface, 1,800 kilowatts of radio-frequency generators are required.

Although the high-frequency equipment of a tin-plate mill is more eye-catching, the electric drive equipment for the line itself is spectacular in its requirements. The adjustable-voltage drive system for a typical electrolytic tinning line with a maximum speed of 2,000 fpm consists of 134 d-c drive motors totaling 1,450 hp and ranging in size from 2 to 200 hp. The control boards for the line are the longest industrial process units in existence. The 134 drive motors must function as a unit during starting, stopping, and as the speed changes over a range of approximately 10 to 1.

AN ELECTRIC REGULATOR FOR STEAM TURBINE

A turbine-driven alternator was required to maintain frequency very exactly, regardless of sudden load changes, more exactly than obtained with the conventional hydraulic governor. By way of electronics comes a static regulator with faster response (Figure 5).

The electronic governor can give a steady-state regulation (change in frequency from no load to full load) of $\frac{1}{2}$ of 1%. The amount of overshoot when recovering from a transient condition has been reduced considerably. And recovery time to a steady-state condition with sudden removal or addition of full load is limited to less than 2% addition to the speed regulation.

The basic part of the electronic unit is a frequency net-

work that detects the variation from the basic frequency and provides a signal voltage proportional to this deviation. This signal voltage is operated on by a stability network and amplified to control the solenoid cup valve—the important connecting link between the hydraulic system and the electronic system. The solenoid cup valve, in turn, controls the hydraulically operated steam-inlet valves.

This unit was designed specifically for a small turbine-generator set, but is equally applicable to Diesel and carburetor-type engine-driven generators and to large central station equipments as well.

CRANE CONTROL—LOAD-O-MATIC

In an effort to obtain an a-c crane-hoist control system with improved performance—speed regulation and stability—we further developed our system, using saturable reactors to apply unbalanced voltage to a wound rotor motor. The result is a control system using neither an artificial load nor load brake, and it produces performance adequate for the most exacting hoist requirements (Figure 6). Improved regulation at all speeds and a low minimum speed permit careful spotting of loads over the entire range of crane capacities.

This is accomplished by the addition of a load-sensing device—load detector—incorporated into the crane rope system. Mechanical deflection proportional to load on the hook operates through a magnetic inductor to control the saturation of the reactor. This regulates power flow to the hoist motor. The system also, to a large degree, divorces motor torque from motor speed—heretofore closely related functions—and permits speed and load to be limited as required to obtain the desired crane performance.

Active developments of a-c crane control using the principle of variable unbalanced voltage have been in progress for the last eight years. With the paralleled development of magnetic amplifiers, we see a bright future for this method of a-c motor control, not only in the crane field but also for movable bridges and other applications requiring refined performance over a wide load range. The future should also bring with it a simplification of circuits now employed. (*Applause*)

* * *

Chairman Lublin: Thank you, Mr. Benedict.

We have time for just about three questions. Does anyone have a particular problem on his mind which he would like to have clarified?

Irving Kahn: What improvements have been made in respect to the sensitivity of home thermostats?

Mr. Cross: Robertshaw-Fulton does not make home thermostats and so, speaking for my own corporation, I cannot say. Actually, improvements have been made so that you can get the sensitivity you want.

Sam, can you add anything to that? This is Mr. Eskin of our corporation staff.

Samuel Eskin: Provision has been made for it. There is a coil that provides heat for the blade, which moves ahead faster than the temperature change in the room. It gives much closer control.

Chairman Lublin: Are there any further questions? If not, the meeting is adjourned.

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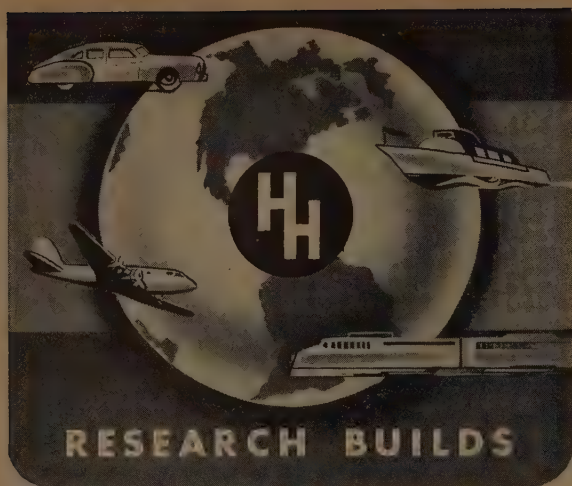
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Peacetime Impact of Atomic Energy

THURSDAY AFTERNOON, NOVEMBER 8, 1951

GLENELG P. CATERER, chairman, presiding.
Chairman Caterer: Come to order, gentlemen.
As you know, the topic for this forum is "Peace-time Impact of Atomic Energy."

It seems to me that those who are serious about their hopes for our civilization may find two rays of hope: (1) that the weapons themselves are so frightful that we may never have to use them, and (2) that the benefits from the use of the facts found may offset the usability, let us say, of these weapons.

I am sure that many of the scientists and engineers who have given of their genius for the development of the results of nuclear fission think of those hopes.

Knowledge of the potential peacetime uses, of course, is incomplete. The subject is too new, and too much information is classified to be completely explored at this meeting. We hope some contributions to that knowledge can be made. We have tried to divide the program into three parts: (1) having to do with the raw materials that go into the program, (2) the possible developments along the lines of power and heat, and (3) instrumentation.

The first speaker, dealing with the first of these three topics, is Mr. Evan Just. Mr. Just has been on the staff of the *Engineering and Mining Journal* since 1942. He has been editor since 1944. He is a geologist and engineer. He taught geology and oil operation at the New Mexico School of Mines, and he has taught courses in mineral economics at Columbia University.

Before becoming associated with the *Engineering and Mining Journal*, he was secretary of the Tristate Zinc, Lead, and Ore Producers Association, and he spent a year and a half, on leave, as director of the strategic materials division of the Economic Cooperation Administration. Ladies and gentlemen, Mr. Just. (*Applause*)

* * *

Evan Just: Mr. Chairman, ladies and gentlemen: If I should stick strictly to the subject assigned to me, I would be over in something less than five minutes, and I would no doubt win your genuine gratitude; however, I thought it might be worth while to add to that mineral portion of the subject some background on uranium which I believe will be of interest to you and which I believe will help set the stage for this program.

First of all, we can say quite clearly, from the geological resource standpoint, that no programs, of either fruitfulness or power consumption, are going to be lacking because there is not an adequate supply of raw materials. Uranium is a relatively abundant material, although it does have the peculiar property that most of it is so finely disseminated in the granitic platforms which compose the main portion of the continents that it is questionable, at least insofar as I know, whether it can be extracted effectively. However, there is a great deal of uranium for such purposes as

we have in mind in greater concentrations than these minute concentrations in the granite platforms of the continents.

Uranium is classified as the twenty-fifth most abundant element, and that places it next to copper. It is twice as abundant as zinc and something like four times as abundant as lead; although, up to the present time at least, it has not proved of the same order abundance that you might call extractable sources.

Uranium, in more concentrated forms, occurs in more than 100 minerals. On top of that, it is one of those elements that have the interesting habit of stepping in on the space lattices of molecules and being unidentified as a mineral. I suspect that in a good many of the occurrences, and in the forms in which it goes from one natural occurrence to the other, it is probably, in this, disguised as an interloper of the space lattice of some molecule where it does not belong.

I shall not go into a discussion of the various types of deposits that contain uranium in apparently commercial types, except as I describe to you some of the deposits.

Let us consider what we term the prebomb history of uranium to see what kind of substance it was before it became such a focal point of attention.

Uranium was produced in the prebomb world at such a rapid rate that it was, in effect, a drug on the market. It was largely a by-product of either radium mining or vanadium mining. For example, Mr. LaBine, the prospector who discovered the Great Bear Lake deposits, and who was head of the great Canadian firm, had quite an inventory of uranium salts on hand when this new disturbance blew over the hill. That was very fortunate for us because we were able to acquire that inventory; however, before that, it had been such a drug on the market that the price for the uranium contents had been only about \$1 a pound.

Mr. LaBine preferred to hold on to it rather than sell it because it was not a basic source of income for his radium mine and refinery.

To trace the history briefly, the oldest mine was at a place in Bohemia. It was called Joachimstal. You have no doubt heard stories of how the Russians are putting slave labor into these mines at the present time in a furious attempt to attain a maximum production.

Mining, at that place, is centuries old; however, it was formerly essentially for silver. I might say that the word *thaler* came from the hind end of this locality, so to speak, Joachimstal.

Uranium has been mined there ever since the middle of the last century, and so it is not particularly new. I might say, incidentally, that up until the time of the atomic era, uranium was used in the pottery and glass trades as a coloring material. It had a potential, and not very poor use, as a ferroalloy.

Madame Curie discovered uranium from ores of this lo-

cality. When radium became a commercial product, an industry started up in western Colorado, where we have a large area of sedimentary rocks containing vanadium, uranium, and, as always, a small percentage of radium.

There was a mushroom industry in Colorado around 1910. Those of you in the financial world probably know Arthur Bunker, who is now president of Climax Molybdenum, and who not long ago was executive vice-president of Lehman Brothers. Bunker got his industry start out there developing these radium deposits. Then along came the Belgian Congo deposits, which proved to be so much richer and more productive that they created a depression in the Colorado radium industry from which it never recovered.

Radium, from that time on, was purely a by-product of the Colorado activities. The vanadium activity is what carried the ball out there from then on. It was a stop-and-start industry. Vanadium has been a war baby in metal, and it had its ups and downs. Both uranium and radium were by-products, after the Belgian Congo deposits, which are still the most important in the world, stole the show and put them out of business.

Along about 1930 came the interesting discovery on the shores of Great Bear Lake, in the Arctic, and it proved to be an active competitor. So that, when the atomic system burst upon us, the radium world was divided between two competitors operating under a cartel, and practically no other source of uranium was available. The Congo was getting 60% and the Canadian 40%.

Those deposits in the Congo and in Canada are called pitchblende or uranitic deposits. They are primarily deposits from igneous sources, and the sedimentary deposits such as are around in the Colorado plateau are simply derivatives by erosion from that class of deposits.

Incidentally, at Marysville, Utah, they are developing a deposit of the igneous type which apparently is a clue to the primary origin of those deposits on the Colorado plateau.

The characteristic ores are called carnotite ores and are interesting because of their bright canary yellow color. You can see them in any museum if you are interested. They usually are accompanied by a photographic film on which a key or coin has been exposed, and the natural radioactivity has developed an impression on a photographic plate. I have never seen a museum display without that prop along with it.

Since that time, new sources have been developed which we could call commercial in the restricted sense that they are either underdeveloped or are clearly susceptible to development within the economic potentialities of utilization. That almost sounds like Government gobbeldegook or almost as bad as what some of you security people throw at us.

The Colorado plateau deposits have been extended, as geologists knew they would be, over quite an area. The production has pushed over into eastern Utah and the potential area is considered to go approximately as far as the middle of the state in the southwest portion; in other words, right over to Bryce Canyon, roughly speaking, and then to the Navajo Reservation area, the Monument Valley region, and deposits which are exploitable under present

conditions have been found as far to the southwest as Grants, N. Mex., which is not very far to the west of Albuquerque.

In that rather wide area there is a lot of uranium. It is relatively low grade. Most of the ore deposits are chancy, and so, just because you have one, do not consider that you are automatically in the business for life. You have to keep on your toes. Nevertheless, the Atomic Energy Commission has made it its business to offer sufficient lures to keep the boys interested out there, and the region is now teeming with prospectors and small miners. A few good-sized companies are now getting into the game. The Sante Fe Railroad has undertaken to develop some of its own, and the Climax Molybdenum Company has formed an affiliation, and it is probably the largest operator in that area. Anaconda Copper Mining Company has also entered the field. Beyond that, there are any number of individuals working there and many small organizations. They must run into the thousands.

Here is another interesting new source which has come up. It has been discovered that, with most marine phosphate deposits such as exist, for example, widespread in our Pacific Northwest, in Idaho, northern Wyoming, in Oregon and Montana, there are associated some amounts of uranium.

I might call your attention to the fact that, although I am not aware of any scientific identification of uranium with any organic compound, most of these sedimentary deposits are usually highly fossiliferous and suggest the possibility that organisms, in one way or another, help act as transfer agents for the material as it moves from the erosion of primary rocks to sedimentary rocks. I might also say that the extensive and important phosphates of Florida, which are our principal source of phosphate rock today, have small concentrations, but nevertheless immense tonnages, of treatable material, and there is activity today in investigating the possibilities of the development. That same potentiality would exist in the several places in the world where phosphate rock is found of marine origin.

Then, down in the Witwatersrand, the great Rand gold fields of South Africa, small amounts of uranium also have been discovered, and preparations are being made to extract the uranium, both from the ores coming out of the mines and from the oil shale tailings which are very extensive in the area. Although they are very low grade, they add immense tonnage potentialities to uranium.

In addition, uranium is known to exist in certain oil shales. In the prebomb era, for example, it was recognized in Sweden that a certain oil shale tailings pile had deposits of uranium, and it was being held for future consideration.

I might say also that uranium was noted in coal in Madagascar in bitumens. So it occurs in association with a lot of rocks that are very common. But by that I do not mean to say that wherever you find those rocks you necessarily find uranium in recoverable quantities.

It is asserted, for example, that the Chattanooga shale, which is a deposit of immense extent, practically covers the whole peninsula of southern Michigan, and it extends as far to the southwest as Oklahoma. It is prominent in Kentucky and Tennessee except where it has been eroded or is too deep to mine, and it covers most of the area indi-

cated by those marginal points. It is fairly thin. It might be as thin as 20 feet or as thick as 75 or 100 feet; but, tonnagewise, over such an area, the potential is colossal. That is only one of these potential oil shales that are also believed to be a practicable source of material for uranium recovery.

To give you an idea how these look in figures, in what they term "proven reserves," at approximately present cost, which I understand to be in the general neighborhood of \$25 per pound of metal, the so-called United States proven reserves at current prices are considered to be approximately 100 million pounds.

Also, there is an additional reserve in lower-grade material, chiefly in shales, which is considered to be approximately 1 billion pounds. Obviously, any such guesses are very loose. I can only remark that, every time geologists or engineers have undertaken to estimate resources, they have invariably been ridiculously short of the mark, and so you are taking a pretty good gamble if you assume that those figures are low as far as the margin of error is concerned.

That latter figure of a billion pounds is considered recoverable at approximately \$50 a pound, and Mr. Swain, your next speaker, was showing me some figures in a recently published book on uranium yesterday. According to this computation, which is somewhat theoretical, admittedly, uranium at \$2,000 a pound would be thermally equivalent to coal at \$1.60 a ton, so that you see \$50 a pound is apparently an entirely digestible figure, based on which the atomic power or atomic weapon industry can obtain its supply.

I might say, incidentally, that the 100 million pounds of so-called proven reserves are the equivalent of 100 years of the 1946 rate of power generation; if you assume that you throw the whole 1946 electric power generation load on uranium, this larger figure of \$50 reserves is the equivalent of 10,000 years of operation: that is, of electric power generation at the 1946 level.

That gives you, I think, a pretty fair idea as to why I say that we are not going to abandon programs in that direction for lack of uranium.

To get to the narrow subject which I was asked to talk about, it is really rather simple, at least the part that can be told. The Atomic Energy Commission has made it its business to provide the price necessary to keep the numerous, ambitious, private entrepreneurs busy looking for uranium. They have declared a price guarantee over a certain logical period. I believe it is five years. Beyond that, they have offered a \$35,000 bonus to the people who will discover an important high-grade deposit that will produce a given tonnage. Furthermore, they furnish geological assistance, and they do a considerable amount of drilling, the results of which are available to the operators, so that, generally speaking, although there was much complaint in the early days about the unrealistic attitude of the Commission toward the problems of the private operator—and you can assume, of course, that under any such conditions somebody will always complain—they seem to have ironed out the wrinkles pretty well, and they have a set of incentives to take care of those who are working on it. There are the

possibility of a reward and enough people actually earning rewards so that they have a great army of people out looking for uranium. By that I mean, you understand, professionals. Of course, anyone can go over here to Abercrombie's and buy a Geiger counter and start looking for it on 42d Street.

That is not so ridiculous as it sounds, because I might say, first of all, that I read in a book from Columbia University that they did have some uranium minerals on the Island of Manhattan. I cannot say just where, however. Furthermore, we still do not know in what queer spots it might pop up, either it or its companion, thorium.

For example, more of the interesting strike near Sheridan, Wyo. This is thorium. The strike was discovered because a rural postman, an RFD man, was carrying a Geiger counter, and at a totally unsuspected spot the thing started to show. It started quite a burst of local excitement. A few groups of people have set up claims. No one knows yet how commercial it will be, but that is just an indication that you can almost say that any boob might find uranium almost anywhere, and it is not wholly unrealistic to hope that a great many of these outsiders, so to speak, who for one reason or another might be carrying around a Geiger counter might come upon something.

I should like to say just a few words about thorium, which, at least, is a potential companion to uranium. Thorium has come, almost exclusively, from India and Brazil. There were deposits down in the Carolinas which furnished us with some, but the main world sources have been in those two countries. Thorium occurs in what we term the pegmatites, which is a class of igneous rocks associated with granites which never seem to make up into large ore bodies. They are the principal source of mica and of feldspar because they usually have relatively gigantic crystals. They produce a good share of the world's beryl. They contain uranium and thorium minerals in a good many instances; however, they are so erratically distributed in pegmatites, and the pegmatites are such trustworthy bodies, that they must be regarded, essentially, as by-product sources. However, the plaster deposits, comprised of principal sources of thorium, are simply concentrations by erosion and sedimentation of the heavy mineral monacite, which is the common thorium-bearing mineral, and it may develop, inasmuch as granitic areas are very large and have been eroded in many instances throughout geological time. We may run into a good many surprises as to where plaster thorium may be found, given a sufficient price. I do not think it is going to be so important as to what you might term fast commercial prices, but, if some comparatively fantastic price is placed on it, I predict that there will be lots of places where plaster thorium will be found where pegmatic areas have been eroded and this heavy mineral has been concentrated.

I will simply close by saying that we know that the USSR had at least one uranium-producing area, the Fergana Valley, in central Russia, before the war. We know that it has, of course, control of these deposits in Bohemia and in the area known as the Erzgebirge area, in eastern Germany. Also, there was a report before the war, that nobody knows a great deal about, of pitchblende deposit

in Bulgaria, which, of course, is now behind the Iron Curtain. Beyond that, you can take it as a certainty that as large a segment of the earth as is inside the Iron Curtain is not going to suffer from lack of fissionable minerals, either for industrial or destructive purposes. Thank you. (*Applause*)

* * *

Chairman Caterer: Thank you very much, Mr. Just.

Our second speaker is Mr. Philip W. Swain, who is the editor of *Power*. He has been with them for thirty years, not always as editor. He has been editor for the last fifteen years.

It would be difficult to find a man with a longer record and a fuller knowledge of the implications of atomic power. In July of 1940, the magazine published an article written by Mr. Swain entitled "Uranium 235—a Power Field of the Future." That was the first article in a technical magazine on atomic power, and I suspect it was the last until after Hiroshima.

He was also the editor of the first magazine devoted to atomic power, which was later absorbed by McGraw-Hill's publication *Nucleonics*. He was McGraw-Hill's press representative at Bikini.

Mr. Swain has taken this assignment on very short notice, and we are all very deeply grateful for it. He, like Mr. Just, has been at a meeting all day, which he left to come here, and he goes back to a meeting this evening. Both these gentlemen have made quite an expenditure of their time and energy to address us today. Mr. Philip W. Swain. (*Applause*)

* * *

Philip W. Swain: To save a little time for speaker no. 3, who will probably have a more interesting speech than mine, I am going to proceed at the rate of 60 miles an hour. First I will start with the answer. Most of the authorities who have discussed this thing think atomic energy will not be important in a big way in less than twenty years. I do not see any reason to disagree. When this finally happens, in twenty, thirty, or forty years from now, we might be saving as much as 1% of the national income by using uranium instead of coal; maybe not. If I were a security analyst, which I certainly am not, I would not pay a great deal of attention to the future of atomic energy power in deciding on any investments in utilities or industry, and so on. I wish I had time to go into that.

Atomic energy is big business right now because the Atomic Energy Commission is dumping in hundreds of millions of dollars. Somebody is getting the orders. I am talking about commercial generation of power without any subsidy, and it looks as though it were far in the future.

The bomb from the investment angle is far more important today than atomic power. If I were to look at industrial plants from this angle, I would rate (1) the bomb to have more effect, more value, than the future atomic power, (2) science and all of the study being done on the atom and isotopes, and (3) atomic power. I hope the time will come when somebody, somehow, will be able to shove the bomb to second or third place.

I have given quite a bit of thought and attention to the

bomb. I have written a piece on it in which I attempted to analyze the effects of the atom bomb in terms of arithmetic and geometry instead of in terms of theatrical adjectives.

Very briefly, going into natural uranium, it consists of one part out of 140 of uranium 235, and the other 139 parts out of 140 of uranium 238. Chemically, they are exactly the same. If you could take uranium 235 and split all the atoms—which you might call burning it—you would have the heat equivalent of 1,250 tons of coal to 1 pound. Having gotten that, you could do with it what you could do with any heat. You could heat a building, turn the heat into power, or make a bomb. You could do the same with natural gas.

Uranium 235 releases its heat by the process known as fission. A neutron hits the middle of the atom and splits it into two parts. In separating, it gives off a couple more neutrons, two or three, and tremendous energies. If you split all the atoms in uranium 235, you will get heat equivalent to 1,250 tons of coal per pound. This can go on if the hunk is large. If it is a small hunk, it will not happen.

In the atom bomb, they take a quantity of uranium 235, bigger than the critical quantity, and they have it in two separate parts. They bring them together in a great hurry and create a critical quantity, and it proceeds to destroy itself and blow itself apart. After 2 pounds have been exploded, the reaction starts. The explosion of 2 pounds releases what you saw at Bikini.

If we consider natural uranium, such as Mr. Just was talking about, it will not maintain a reaction by itself unless we put it in a structure known as an atomic pile, which might be a cube made up of blocks of graphite, 10 or 15 feet along each edge, and it fissions itself under controllable conditions. We would pull a rod in and out and get from that pile some zero output up to 100,000 kilowatts of heat. It changes from one to another in a few seconds without anything moving but the rod. That was made at Hanford during the war. The purpose of it was to make plutonium. In the operation, the neutrons turn the thing into plutonium. The plutonium, being a different chemical from uranium, can be separated chemically. It was separated and put in a bomb, and the plutonium is as good as uranium 235. Although it could be separated chemically, it would kill the chemist; therefore, the separation must be conducted by remote control.

That would be one of the difficulties of operating a power plant with the same stuff. We have a big cube of graphite with holes in it. In each hole we put a cylinder of natural uranium in an aluminum can. We leave it there for a while, and then it begins to poison itself, and somebody has to take it out. We cannot touch it. We must put it in a chemical laboratory and dissolve out the stuff. We separate the poisons, throw them away, and then put the good part back in.

It would seem simple to get power because, when it operates, it gives off heat, but the heat is ordinarily given off at low temperature.

At Long Island, they blow air through it and blow hot air up. They could put water-heating coils in that air if they thought it was worth while. If we want to make power out of heat and do it economically, we have to have

high temperatures. Engineers are having a whale of a time trying to put anything in the pile that will serve them for the generation of power. All the metals are wrong. Steel is no good.

Let us say that we do want to make power. How would we do it? We would have the blocks of graphite and pipes running through them. Through the pipes we would pump, not water, but inert gas or a molten metal. That would pick up the heat. Then we would transfer that heat from that fluid to water-produced steam, and then it is just an ordinary power plant. All of the trouble associated with the generation of atomic power resides in the part of the plant where we produce the heat originally.

I indicated that the future of atomic power is rather dim for a good many years. It will not be so because the fuel is expensive. The cost of fuel will be practically zero. If we start with uranium 235, one pound of it would be equal to 1,250 tons of coal. When we buy a pound of natural uranium, we have only the equivalent of 9 tons of coal. It now appears it may be possible to breed. We will have a plant in which we will have more fuel at night than we had when we started in the morning. When we burn up a pound of uranium 235, it will produce more than a pound of plutonium, and we will end with more than the amount with which we started. We will be getting 1,250 tons of coal heat out of \$50 worth. That is equivalent to coal at 4 cents a ton. That is shippable at zero cost because by air freight we can ship 100 pounds to Chicago at a cost of 35 cents a pound. We could ship one pound for 35 cents. That is the equivalent of 1,250 tons of coal. Shipping 1,250 tons of coal by rail would cost \$3,000. That looks pretty good.

Don't rush out to buy stock. All the discussion is based on the assumption that the cost of fuel in an atomic power plant will be zero. The only thing the atomic power plant can do for us is save the price of coal. The atomic power plant will cost more. From the investment angle, all we have to do is balance the additional cost of the atomic power plant against how much coal we would save.

If we figure on the basis of 15% fixed charges, on a plant operating at 50% load factor, every \$100 we add onto the cost of the plant can be justified by an additional operating saving of 3.4 mills per kilowatt-hour. If the plant should cost \$300 more per kilowatt-hour to build than an ordinary coal plant, we would have to show we were saving that. The only possible place we could save it is in the cost of coal. If we burn coal at \$10 a ton, the coal only costs 3.7 mills per kilowatt-hour.

Let us equate those figures. Putting them together, we find, assuming this percentage and assuming a 50% load factor, that, if a plant costs \$100 more, we break even at \$9.50 coal. If it costs \$200 more, we will break even at \$19 coal. If it costs \$300 more, we would have to have \$28 coal to make our plant cheaper.

Since the fuel costs nothing to transport, we do not have to consider that. The ideal plant would be one operating at a very high load factor, such as for aluminum. It would have to be a big plant. It would have to be located where coal is very expensive. In about fifteen years, we may begin to have plants like that in places where coal is expen-

sive. It may be used to run ships and some heavy planes used only for military purposes. It will never be used for automobiles.

I have to cover myself in case we see some big plants operating in four or five years. There is a cold war going on, and people want to make bombs. If we do, we have to make piles. Since we have to run them anyway, we might as well pick up power, and, if we do, we will have to sell at commercial rates. We could make power inexpensively as a by-product of bomb production. I hope the time will come when we can have a talk about that.

Can we produce electricity directly from the fission? Maybe, theoretically; but all of the people with whom I have talked think they cannot see any conceivable way of doing that. However, if somebody should discover a way of making electricity directly from fission, without going through an intermediate stage, that would be revolutionary, and I would have to start all over again and figure out a new speech.

You must pardon me for going so fast, but I am sure the next speaker will appreciate the fact that I am not using too much of his time. I think his talk will be interesting, and I know you will appreciate my hurrying.

I think that the important and widespread generation of power from atomic energy is quite a distance in the future. The only possible saving the atomic power plant can accomplish is in the cost of coal. The cost of the atomic fuel can be considered as zero for all practical purposes. The atomic plant will cost more. Therefore, we will compare the greater cost of the atomic plant with the coal we would save.

Also, I will remind you again that, in spite of all I have said, the atomic energy field is great business right now because of the money that the Atomic Energy Commission is dropping into it. I am in favor of their developing it to the greatest possible extent. Since we have no control of the atomic bomb, I want to add that the atomic bomb is more important to us than atomic power from every angle, including the angle of investment. Thank you. (*Applause*)

* * *

Chairman Caterer: Thank you, Mr. Swain.

It is usual at this time to provide a five-minute break, but I am informed that three functions have been scheduled for this room today. One was a session on synthetic fibers, which has been held; another is a session on atomic energy, which is being held; and the third function is cocktails which will follow.

To provide room for the third forum, we will continue with our next speech.

The next speaker is William A. Kerr who is vice-president and general manager of Tracerlab. He does not have a long record with Tracerlab; nobody has. I am very glad to have him here and have him participate in this program. Mr. William A. Kerr. (*Applause*)

* * *

William A. Kerr: I have always admired fellows who get up to speak before a nice audience like this and say, "A funny thing happened to me this morning on the way to

work," and then they go on to tell a funny story which fractures the audience. I have been coming to work and going from work, as a man and boy, for about twenty years, and nothing funny has ever happened to me (*laughter*) until this morning. (*Laughter*)

I met an old friend who asked whether I heard Harry Truman last night. I told him I did hear him. He said, "That was a pretty good speech about the limitation of arms."

I said, "It will be a good thing."

He said, "I understand he received a cable from Joe Stalin, and Joe said he is in favor of it. He said he was going to co-operate in the limitation of arms. He said he was going to make shorter guns." (*Laughter*)

As a result of the wartime research in the field of atomic explosives, one extremely important tool became available shortly after World War II. As a by-product of the nuclear piles needed for bombs, radioactive isotopes were made immediately available for research, medical, industrial uses.

A radioactive isotope or radioisotope is an element or compound that has been made radioactive and emits radiation. It acts chemically and physically exactly like the original compound, except that it also emits radiation. This means a radioisotope can be followed through a complex reaction because its presence is made known by its emission of radioactivity. It is the purpose of this talk to:

1. Give a general explanation of radioisotope properties and how these properties are useful.
2. Explain briefly the detection and measurement instrumentation.
3. Give illustrations of typical applications in the several important areas of use.
4. Discuss the business aspects of the isotopes and instrumentation section of the over-all nucleonics industry.
5. Have a quick look at what the future may hold.

PROPERTIES

Definitions. 1. *Radioactivity* is the emission of minute particles of energy waves (similar to X rays) from the nucleus of the atom.

For the purposes of our discussion, we can consider isotopes emitting three types of nuclear radiation: alpha, beta, and gamma. Alpha radiation consists of relatively large nuclear particles which do not penetrate beyond the outer layers of the skin. Beta radiation consists of small nuclear particles of greater penetrating properties. Gamma radiation consists of energy waves which are very penetrating. X rays are gamma rays.

2. *Half life:* All radioisotopes are constantly giving off radiation. To describe the decay of a radioisotope, we use the term *half life*, which is the length of time required for the activity to fall to half its initial value. This varies greatly with different isotopes. Carbon has a half life of 5,000 years, whereas gold has a half life of 2.7 days, and iodine 8 days.

Medical Field. Three broad areas of biological and medical applications are:

1. Investigations by tracer technique of complex biological processes.

2. Assistance in diagnosis of disease.
3. Aid in treatment of disease.

Industry. Six general ways in which isotopes can be used industrially are:

1. Penetration and reflection: Thickness, bulk density, and specific gravity measurement. Nondestructive "X-ray" photographic inspection of solids or industrial radiography.
2. Tracer: Tracing complex flow of liquids and gases, measuring extreme dilutions and homogeneity of mixtures, and detection of new chemical agents.
3. Sterilization: Killing organisms in sterilization of food and drugs without heat and while they are in containers.
4. Ionization: Elimination of static charge in air and other gases. Introduction of ionization to start arcs or regulate voltage.
5. Luminescence: Incorporation of radioactive chemicals in materials such as plastics, paints, ceramics to render luminescent.
6. Initiation of chemical reaction: Accelerating or induction of chemical reactions by radiation.

DETECTION AND MEASUREMENT INSTRUMENTATION

The human senses—sight, hearing, touch, taste, or smell—all fail to detect radioactivity. Instruments or devices must be used to detect radiation. Geiger counters, ionization chambers, or scintillation counters are usually used, although electroscopes and photographic or chemical means are also available.

A Geiger counter is a thin wire anode with a metal cylinder cathode around it in a sealed chamber. A voltage is applied, and radiation causes a discharge which gives a pulse. These pulses can be counted or made to actuate a meter which gives a rate of radioactivity. Since this is a very weak pulse, electronic amplification is usually used.

An ionization chamber is an electrical device containing two electrodes in which the current flow caused by radiation is measured.

A scintillation counter consists of a crystal, which transforms radioactivity to light, and a photomultiplier tube, which measures the light electronically and with proper amplification actuates a meter or counter.

These detectors are used with a great variety of electronic equipments to measure radioactivity in its many applications. The design and manufacture of suitable electronic equipment to measure conveniently, with suitable precision, is the basis of the nuclear instrument industry.

APPLICATIONS

Research. In research work, many biological and chemical processes have been investigated and understood for the first time by use of the tracer technique. This involves tagging a compound by making a suitable atom radioactive and following it through the process by means of a Geiger counter. By measuring the radioactivity at various phases, it is possible to determine what has happened.

Medicine. Isotopes are used in many different ways in the medical sciences.

Radioactive cobalt, a strong gamma emitter, is used in place of radium and X ray for treatment of cancer and

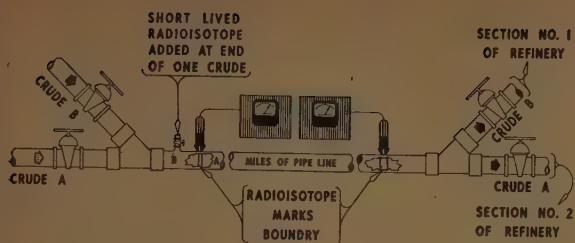


Figure 1. Radioactive Isotopes for Tracing Oil Flow in Pipe Lines

Advantages:

1. Radioactive marker can be traced over long distance.
2. Marker spreads to only small oil volume.
3. Permits separation of crudes with minimum of loss.
4. Method quick and requires no sampling.

other diseases. Cobalt is less expensive than radium, and there is an abundant supply. For instance, the Atomic Energy Commission reports that a single radioactive cobalt cancer treatment unit gives more radiation than the total prewar supply of radium.

For some medical treatments for tissue near the surface, pure beta radiation is more suitable than gamma radiation. Thus, the strontium eye applicator is widely used for tumors of the eyelid.

The wide variety of isotopes now available has opened a whole new field of internal application of radioactivity for diagnosis and therapy. From the many isotopes known, it is possible to select suitable radiation, half life, and biological affinity. For instance, radioactive phosphorus for leukemia, radioactive gold for tumors, radioactive iodine for thyroid.

Radioactive iodine is the most widely used isotope in medicine and has achieved very practical success in clinical use. It is used for the diagnosis and therapy of thyroid diseases and is available commercially in package doses from two firms, Abbott Laboratories and Tracerlab, Inc.

In suspected hyperthyroidism, a tracer dose of radioactive iodine is given to the patient by mouth, and the uptake is measured by a counter placed at the patient's neck over the thyroid. In normal patients, the uptake is 10 to 20%, and in hyperthyroids it is over 50%. In many cases of hyperthyroidism, diagnosed this way, a much stronger therapeutic

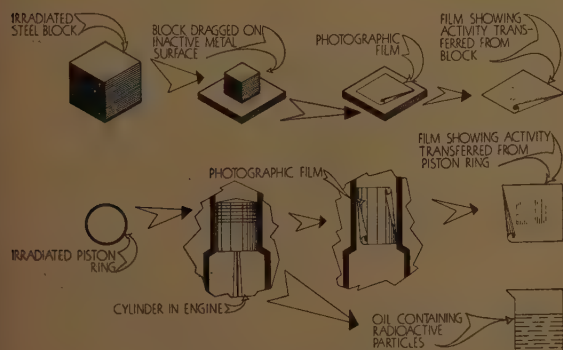


Figure 2. Friction Studies

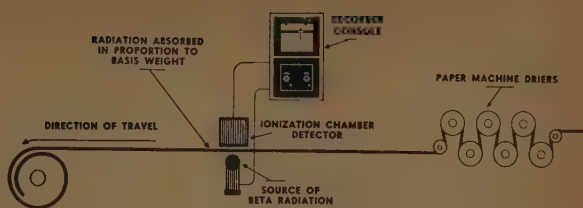


Figure 3. Strontium 90 for Beta Ray Basis Weight Gage

Advantages:

1. Not affected by moisture or chemical composition.
2. Gage does not contact sheet.
3. Measures directly in weight per unit area.

tic dose is then given with excellent results. The Tracerlab Geiger tube and scaler operating here before you are typical of the instrumentation used in this work.

Industrial Applications. In the chemical and petroleum industries, tracer techniques are widely used for many applications. An example of practical tracer use is in tracing oil flow in pipe lines. In Figure 1 the pipe line is used to transport successively different crudes from the oil field to the refineries. After crude A has flowed through, a short-lived radioisotope is added, and then crude B is flowed through. At the refinery end, a Geiger counter permits separation with a minimum loss of oil.

Wear studies are an example of a different sort of practical application of radioisotopes. In Figure 2 the steel block has been made radioactive. If it is dragged across an ordinary piece of metal, an infinitesimal amount of the steel block will be transferred. This is too small to measure by ordinary means, but a photographic film placed on the piece of metal will show the transfer. The radioactivity will expose the film, and the degree of blackening is a measure of the amount of radioactivity.

Similarly, studies have been made of engine wear by irradiating piston rings at Oak Ridge and running them in an engine. The wear of the ring can be determined by the film, and a study of metal particles in the oil can be made by a Geiger counter. This method has also been used to study the efficiency of lubricating oils, and quantities of metals as small as one millionth of an ounce were measured. Standard Oil of California made such a study and says these findings formed the basis of an oil which doubles engine life.

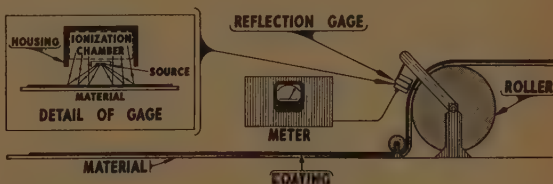


Figure 4. Radioactive Source for Reflection (Back-Scattering) Thickness Gage

Advantages:

1. Can measure thickness of coating and/or material.
2. Measurement made from one accessible side.
3. Can measure a variety of materials with one calibration.

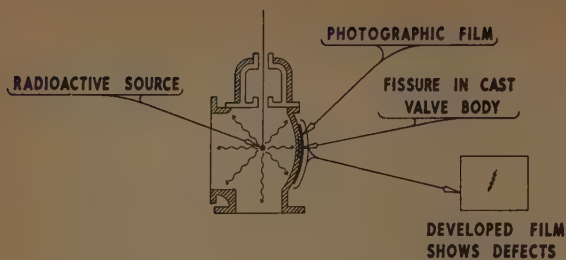


Figure 5. Radioactive Cobalt (Co 60) for Radiography Testing

Advantages:

1. Versatile and reliable inspection.
2. Inspection made without dismantling.
3. Sources of desired shape and size.
4. Very high activity sources available at low cost.

Thickness measurements and basis weight measurements are of tremendous importance to the paper, rubber, plastic, and metal industries. Figure 3 shows the operation of a radioisotope gage called a beta-ray gage because the radioisotope used is strontium 90, a pure beta source. This source is placed below the traveling sheet, and an ionization chamber detector is placed above the sheet. The radiation is absorbed in proportion to the basis weight. By means of a meter or recording device, deviations in basis weight or thickness from the specification can be seen immediately and corrections made. It is also possible to have the detector actuate a servomechanism and automatically correct the roller settings. The savings due to this control pay for the gage in a few months. You see here on the table an operating Tracerlab beta gage. The great sensitivity can be seen by watching the meter needle when a very thin sheet of tissue is placed in the beam of the beta rays.

Obviously, rubber, plastics, metals, roofing, linoleum, carpeting, and such can be measured in the same manner. For thick metals, a gamma source is used.

Coating measurements can be just as easily made by using a back-scattering or reflection principle. In Figure 4 the problem is to measure the coating on a base stock. Coatings on paper, adhesives on cottons (as in adhesive tape), rubber on fabric for rubbers, boots, and the like are typical examples. In this instance, the beta source is mounted in the center of the ionization chamber, and the reflected rays are a measure of the weight per unit area of the coating. Three companies in the United States are now manufacturing gages of this type: General Electric, Tracerlab, and Industrial Nucleonics Corporation. Prices range from \$2,600 for a Tracerlab gage up to \$10,000 for an Industrial Nucleonics gage. Adaptations of these principles to a variety of special industrial problems are now in development.

Radiography is another large use of radioisotopes. Radium and X-ray equipment are both used to examine metal castings and welds for flaws. Radioactive cobalt is a much less expensive source for radiography. In Figure 5 a radioactive cobalt source is suspended in a cast valve body, and a photographic film attached to the outside of the body records the gamma rays which come through. The flaw is easily seen in the developed negative. Radioactive cobalt

now places radiographic testing within the range of small foundries.

One last illustration of industrial application is the *liquid level gage* shown in Figure 6. A float containing a radioactive cobalt source is guided by wires, a detector permits continuous measurement of the level in the closed container, and the meter or recorder can be made to read directly in volume.

In the food and drug industries, many applications have been made. Tracer techniques have been used to study more economic use of fertilizers. Farmers spend about \$300 million a year for phosphate plant foods alone. The Department of Agriculture says that more has been learned about phosphate fertilizers in the past four years through the use of radioisotopes than in the previous fifty years by other means.

The greatest use of isotopes may be in the field of food sterilization. By irradiation of meat and milk, for instance, Dr. Brounell of the University of Michigan has found that enough bacteria have been killed by this method so that the foods kept at 77 degrees Fahrenheit in room temperature for three weeks without spoiling, as against 24 to 48 hours without sterilization. Nutritional values were unimpaired, but the taste was not completely retained. Further work is, of course, necessary before this is a commercially practical application. Waste fission products from the atomic piles could provide a low-cost source of radiation for this application.

In the pharmaceutical field, sterilization without heat can solve many problems.

The business of supplying isotopes and instrumentation is a part of the larger nucleonics industry which includes pile and reactor construction and operation and atomic power. Wherever an isotope is used, instruments are required for detection, measurement, and so on.

Although the applications in medicine for the masses, in mass production, and food industries, are always of primary interest to financial people looking for growth, it must be remembered also that the many research and control laboratories require, in total, large quantities of isotopes and instrumentation, and supplying this latter field is already a sizable business.

Geiger counters, scalars, radiacs, survey meters, counting rate meter, automatic sample changers, recorders, beta gages, sources, organic and inorganic radiochemical com-

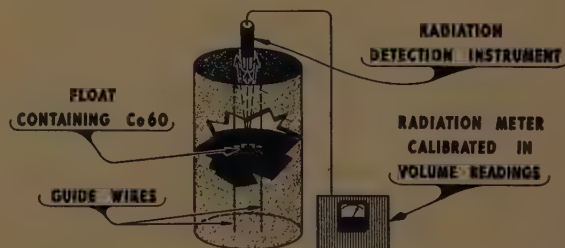


Figure 6. Radioactive Cobalt (Co 60) for Liquid-Level Gage

Advantages:

1. Continuous recording.
2. Measurement made on closed system.
3. Adaptable to automatic control.

pounds, packaged radioisotope accessories, protective devices, film badges, and consulting services are the basic products of this section of the industry for peacetime markets. Typical of a complete product line is the Tracerlab catalog available here to each of you.

My discussion has purposely avoided the defense business, both military and civil, that most companies in the field now have in considerable volume. This consists largely of mass production orders for radiacs of the portable, battery-operated type. This business adds large present volume which cannot be expected in peacetime. However, it has served to put some of the relatively small companies in mass production with consequent cost savings and improved quality in regularly manufactured peacetime products. It also serves to progress the science at an accelerated rate because of the new developments in components and circuitry that are by-products of defense orders. A further advantage is the strengthening of the financial structure of some of these small companies.

In 1946 this industry had just started. For 1949 the Atomic Energy Commission estimated the instrument and isotope industry was about \$8 million. A guess for 1951 is that the industry might do the order of \$20 million including defense contracts.

With another two to four years of civilian and military defense business to keep gross volume up, the adjustment to peacetime economy will not be too serious. This is reasonable because the broader use of radioisotopes in medicine, beta gages, and similar measuring devices in industry, plus new developments, will augment the increasing volumes of present production.

Some evidences of the rate of growth of the industry may be gleaned from recent Atomic Energy Commission radioisotope figures. In 1946 the AEC shipped 246 orders. In 1951 shipments will be over 8,100, a gain of 30% over 1950. Individual shipments total 18,000.

Today, radioisotopes from Oak Ridge are used by 860 hospitals, research laboratories, and individual concerns in 46 states and 31 countries. The total sales, at this wholesale level, of isotopes will be about \$1 million for 1951.

Although there are somewhat over 100 manufacturing companies in this industry in one way or another, many of these make only a few items. Among the better-known in-

strument leaders are Tracerlab, Inc., of Boston; Nuclear Instrument and Chemical Corporation of Chicago; Berkeley Scientific Company of Richmond, Calif.; Radiation Counter Laboratories of Chicago; Atomic Instrument Company of Cambridge; Victoreen Instrument Company of Cleveland; Nuclear Measurements of Indianapolis; Radioactivity Products, Inc., of Detroit; and Beckman of Pasadena, Technical Associated.

Leaders in radiochemicals and short-lived isotopes are Tracerlab, Inc.; Abbott Laboratories; and Texas Research Foundation. Among the large companies that have a few instruments available are General Electric Company and Raytheon Manufacturing Company.

THE FUTURE

A look at the combined research and development talent working in the field of atomic energy is convincing evidence that the tremendous progress already made is only the beginning of something even greater. From a scientific viewpoint, no field of endeavor has ever assembled so much ability to work under very favorable conditions. Rapid and startling advances are likely to continue.

From business considerations it is probable that, if an executive were to list some of the important fields he would like a new product line to go to, he would select (1) the medical field, for diagnosis and treatment of disease, especially malignant diseases, nervous disorders, leukemia, and such; (2) mass production industries, especially fundamental ones like paper, metals, rubber, petroleum; (3) the food industry for higher productivity and spoilage control; and (4) Government agencies.

The radioisotope and nuclear instrument industry is important to all these fields. It is an expanding industry and should continue to grow rapidly.

As analysts, each of you will want to study the nuclear field for yourself to judge the prospects for the future. If I have been able to stimulate your further interest, I am pleased. Thank you. (*Applause*)

* * *

Chairman Caterer: Thank you, Mr. Kerr. We would like to have questions, but we do not have time. The meeting is adjourned.

ALLEGHENY LUDLUM STEEL CORPORATION

Pittsburgh, Penna.

At a meeting of the Board of Directors of the Allegheny Ludlum Steel Corporation held today, October 30, 1951, a dividend of fifty cents (50c) per share was payable December 22, 1951, to Common stockholders of record at the close of business on December 1, 1951. In addition, the Board declared an extra dividend of fifty cents (50c) per share on the Common Stock, also payable December 22, 1951, to Common stockholders of record on December 1, 1951.

S. A. McCaskey, Jr.
Secretary



DIVIDEND NOTICE

AMERICAN-MARIETTA COMPANY

The Board of Directors has declared the following quarterly dividends:

33rd Consecutive Common Dividend

A dividend of 50c per share on the Common Stock, payable February 1, 1952 to Stockholders of record January 18, 1952.

33rd Consecutive Preferred Dividend

A dividend of \$1.25 per share on the Preferred Stock, payable February 1, 1952 to Stockholders of record January 18, 1952.

H. J. HEMINGWAY
President

PAINTS • CHEMICALS • METAL POWDERS
ADHESIVES • RESINS • BUILDING PRODUCTS

NATIONAL DISTILLERS

PRODUCTS
CORPORATION



DIVIDEND NOTICE

The Board of Directors has declared a quarterly dividend of 50c per share on the outstanding Common Stock, payable on March 3, 1952, to stockholders of record on February 11, 1952. The transfer books will not close.

THOS. A. CLARK

December 27, 1951. Treasurer

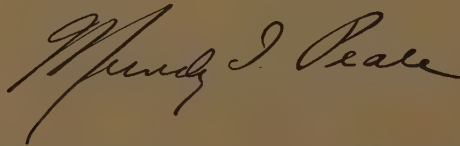
FLEXIBILITY

Of all the priceless qualities which go into the making of our daily living, our form of government, our ability to create and improve, perhaps the most unique possession is our FLEXIBILITY.

It is sometimes a hidden quality. Frequently we depend on it without realizing how valuable it is. But without flexibility we could not progress in the manner we have, either as a free people or as a free nation.

Flexibility is not simply the right to do what we want. It is, rather, the ability to shape and improve and correct the things we do for our own betterment and for the benefit of those around us. Because of the flexibility in our thinking, our country has grown, our standards have improved, our businesses have created better products and services, and our own people and the people of many other countries have profited.

Instinctively we have shunned attempts to harness freedom of action. But, at the same time, we have been flexible enough to agree, jointly as citizens, to proper and just rules of order for the common good. This is the American philosophy.



PRESIDENT

REPUBLIC AVIATION CORPORATION

Farmingdale, Long Island, N. Y.

As designers and manufacturers of the F-84 Thunderjet, now in service in Korea, as well as the United States and many North Atlantic Treaty nations, we are devoted to the principle of flexibility in our thinking as a means of engineering and building new and better U. S. Air Force aircraft. While we are busily engaged in helping prepare our country for any eventuality we constantly maintain the hope that a strong Air Force will continue to be a firm deterrent to the aggressor's desire to make all out war.

The New Metals

THURSDAY AFTERNOON, NOVEMBER 8, 1951

W STURGIS MACOMBER, chairman, presiding.
Chairman Macomber: We will now call this forum to order. I want to welcome you to the Forum on New Metals. Our subject is a very broad one, but we are going to attempt to discuss some of the high spots which are currently of great interest to the analysts in the brief time we have allotted.

We will get right down to business. Our first speaker is Mr. Thomas Lippert, who will talk about titanium. He is a graduate of Carnegie Tech, where he received his BS in physics. After graduating, he became an instructor at Carnegie Tech. He joined *Iron Age* in 1932 and became editor-in-chief of *Iron Age* in 1944. He remained with them until 1949, when he became general manager of the Titanium Metals Corporation. It gives me a great deal of pleasure to introduce Mr. Thomas Lippert. (*Applause*)

* * *

Thomas W. Lippert: Metallic titanium is no longer just a laboratory curiosity. Its development has so accelerated that it may soon aspire to stand alongside the major structural metals. Next year the gross sales of this new metal may well rise to the somewhat impressive \$100 million figure. This is a greater gross production value than the stainless steel industry was able to chalk up in any year in the mid-'30's. As for a tonnage comparison, metallic titanium production in 1952 will very likely exceed the output of primary magnesium in any one of the prewar years and, in fact, should certainly equal the primary magnesium production in as recent a year as 1946.

The somewhat startling situation prevails today in which many design engineers are busily engineering tons of titanium alloys into jet engines and airframe structures, and these same design engineers often have never even seen a piece of titanium metal. And the metallurgical fraternity, habitually a rather unemotional breed, has for these past years sung the praises of this new light metal, even though it has been so scarce that few laboratories could carry on their own research work.

The growth from a few pounds of production only several short years ago to the size indicated for 1952 reflects an intensity of effort somewhat incredible even for the aggressive metals industry of the United States. About the only possible comparison would be with the wartime stimulation of synthetic rubber production, or the even more dramatic birth of atomic energy. As for both of these technological developments, the primary impetus behind titanium metal has been one of military expediency. Titanium metal research and development has been and still is in great part stimulated by Government money, and by rearmament activities. But also, within private industry, there has been a small group of imaginative men alive with the spirit of adventure who have committed large sums of money to meet aggressively the challenge of developing

really large-scale production at unit costs low enough to guarantee survival in the rough and tumble competition of some future year when the rapid rearmament pace, of necessity, tapers off.

The first really commercial method of producing high-quality metallic titanium at a reasonable cost level was the outgrowth of research work conducted by the U. S. Bureau of Mines. This is one agency that has often broken the ground for industry but seldom reaps much of the subsequent credit. Even before private industry recognized the full implications of the 1946 report of the Bureau of Mines, the military—primarily the Air Corps, and the Ordnance and Navy Departments, in this order of activity—saw in this metal the answer to many design problems for military equipment. The military is so frequently lampooned as dragging its feet far behind the industrial parade that, in this instance, it is certainly proper to recognize the courage of those officers in both the Air Corps and Ordnance Department who have persistently stuck their necks out for what they believed to be the best interest of their country. Nor have they been careless with public funds. The execution of many basic research contracts has been characterized by imaginative conception and meticulous administration. (I might say that with clear conscience because we have not accepted any research contracts.) And all the time there has been steady pressure on primary contractors to incorporate titanium into the various new military models while industry has been pushed and exhorted into a parallel productive effort in order to maintain some reasonable balance between metal supply and expanding demand.

The military has just reason to be enthusiastic about titanium. This metal is supported by large ore bodies within the borders of the United States. This may some day be one of the crucial deciding factors on who gets licked if the shooting were ever to start in dead earnest. Titanium, even in this early stage of metallurgical development, can very often perform better in many applications than conventional alloys which consume large quantities of imported nickel and chromium. Titanium, also, frequently outperforms aluminum and magnesium, both of which are habitually in short supply during times of emergency.

Titanium is a light metal, only about half as heavy as steel, and only about 60% heavier than aluminum. But, unlike aluminum and magnesium, the only other two light construction metals, titanium has extremely high strength—in fact, certain of the titanium alloys hold definite promise of being the strongest of all constructional metals available. Even now, no existing constructional metal has a strength-weight ratio comparable to some of the titanium alloys in regular commercial production. Along with its high strength, titanium also has excellent ductility or formability.

Titanium alloys retain great strength at temperatures even above 800 degrees Fahrenheit, whereas aluminum and

magnesium are generally limited to service under 300 degrees Fahrenheit. Unlike the other two light metals, titanium alloys have high shock resistance and great capacity to resist wear and abrasion. Titanium also has an endurance limit higher than any structural metal of any type. When I say titanium, I am usually referring to titanium alloys. Titanium has very low thermal conductivity and thermal expansion coefficients. Titanium is also blessed with quite good fatigue strength. And titanium has phenomenal life in many corrosive environments which would ruin aluminum or magnesium within a few hours or even a few minutes.

Here, then, are about all the desirable factors that the designer might dream of for aircraft construction, particularly in the jet engines and the airframes of the immediate future, which will be subjected to very high stress as well as the heat barrier of high altitudes and high speeds. These physical and metallurgical factors of titanium are also so very favorable to the design of ordnance equipment. Not that titanium is likely to replace the carbon and alloy steels conventionally used in the ponderous guns and tanks, but the Arsenals must look ahead to the time when it may be a matter of survival to put entire armored divisions into the air, fully equipped with all the engines of war for combat far behind the enemy lines. Here every pound of weight will be at a premium. The Ordnance Department already has moved along toward building prototypes of most of their pieces of equipment. Not that ordnance officers are so unrealistic as to view titanium metal at its present price as something with which to build tanks, but with prototypes they can explore what can or cannot be done. When titanium moves into an area of greater supply at more reasonable price levels, the ordnance officers will thus be able to move quickly, perhaps at a time when rapid construction of particular items may be a matter of life or death. Already the ordnance work has resulted in titanium alloy armor plate superior to equal weight of the best alloy steel armor plate.

Perhaps I have tended to overemphasize the military demands for titanium. But this emphasis is merely a realistic recognition of how military requirements will dominate the titanium development over the next several years. One need only examine the outstanding performance of titanium alloys in the compressor sections of the new experimental jet engines to understand why designers want to use 500 to 1,000 pounds of titanium alloys in each engine. Experimental performance in airframe components has likewise been so effective that ordering for the production plants is dictated only by availability of metal and proper alloy sheet stock. In fact, some of the new experimental jet bombers may use 4 or 5 tons of titanium alloys per bomber, if the industry rises to the challenge of producing sufficient quantities of the alloys desired.

However, I do not think any of us look on the titanium metal industry as one that will live only by virtue of the present rearmament program. What is beneficial in war planes is equally desirable in commercial craft. The Lockheed chief engineer has stated publicly that, if it were available, they would use 2 tons of titanium alloy in each Constellation. And the several makers of propellers have initiated extensive research programs to develop titanium

propeller blades, preferably the thin, hollow, broad blades of modern design.

PEACETIME APPLICATIONS

Titanium metal has already a modest number of peacetime applications, even though the availability of metal for such uses has been quite meager. Titanium has really startling resistance to a variety of corrosive acids and already is being utilized by the chemical industry and the pharmaceutical makers for some rather large pieces of process equipment. There are many other installations that will come automatically when our industry gives the chemist sufficient material on which to run his preliminary tests.

Titanium also has the peculiar ability of being impervious to salt water and marine atmospheres under any known condition of service. Surprisingly, the Navy has not yet decided that enough metal is available to permit their use of titanium. It is quite obvious, however, that at some future date this new metal is going to find very widespread application in marine equipment, particularly piping, valves, heat exchangers, and so on which are exposed to salt water and which are so costly to replace. Any of you with pleasure boats can readily recognize the advantage of having metal fixtures or boat parts that would require no protection or polishing.

Titanium has a peculiar and unique ability to resist the pitting type of corrosive attack which spells the doom of all the well-known metals and alloys. Thus titanium will find wide application in encounters with laundry bleach solutions or wool shrinkproofing solutions and similar chemicals which will chew many metals to pieces within a matter of minutes. Aqua regia, which is so severely corrosive to most metals, including gold, is completely resisted by titanium, and concentrated sulfurous and white fuming nitric acids have no effect on titanium, in either liquid or vapor form. This latter chemical, fuming nitric acid, is the common oxidizing agent employed in most rocket devices, and thin titanium containers to handle the acid are high on the priority list. I do not wish to indicate that titanium is a perfect meal for the handling of all acids. As in humans, there is no perfection in metallurgy. Titanium is severely attacked by hydrofluoric acid and concentrated phosphoric acid. But then it is indeed fortunate that some acids do attack titanium, for, otherwise, how would the mill be able to clean the metal or pickle off scale which develops in various mill hot-rolling or annealing operations.

The speed with which titanium alloys win a position in commercial applications a few years from now will depend, of course, not only on the metal's physical and metallurgical characteristics—price also certainly will have considerable influence on acceptance. An exceptional metal, like a very beautiful woman, can be very desirable to everyone, but, if the price is high, both can be enjoyed by only a favored minority. It would be impossible to stand here today and make any reasonable estimate of what might be the market price of titanium metal produced three years from now. Too many changes are still occurring or likely to occur in extractive metallurgy, in melting practice, and in alloy development, to warrant even what might be called an educated guess. However, it should be quite obvious that the Titanium Metals Corporation, and the two companies

that own this corporation—National Lead Company and Allegheny Ludlum Steel Corporation—would not be committing more and more money and more and more energy to this enterprise if they did not have a firm conviction that developments to date assure constantly improving processing technology and also an equally definite assurance of more and better metal at a price that will guarantee titanium a fighting chance when all the metals are hungry for business and slug it out in the dust of the competitive arena.

This confidence on our part in itself represents a great change in thinking over the past several years. It should be realized that, in our new titanium productive effort at the \$185 million former basic magnesium plant at Henderson, Nev., we will be utilizing to a great extent the same process of extraction presented in the original Bureau of Mines report of late 1946. To be sure, this process will be greatly modified, and many efficiencies and cost advantages will result from complete integration of the process and full utilization of all by-products. It may well be that new and better processes in extracting titanium metal from its ores will soon be born. In fact, right here is a new frontier fully as exciting as any of the industrial frontiers of the past. It is a very promising field of activity for some young scientist with initiative and ability. It is quite possible that one man working in his own small laboratory, just like Hall with aluminum, will come up with a spectacular very low-cost means of extracting metallic titanium from its oxide. It could just as well be this one man in his own laboratory as a crew of skilled scientists in a company laboratory. National Lead and Allegheny Ludlum are certainly working very hard on the extractive and melting problems and have moved forward in a very encouraging manner. I would be only human if I expressed the belief that we will continue to lead the development parade.

SEVERAL PROMISING AVENUES OF DEVELOPMENT

As in all other spheres of technology, enough concentrated effort can open up one or several promising avenues of development to master the formidable problems of large-scale titanium production at reasonable cost. I cannot as yet go into detail on how we solve our production problems, but suffice it to say that we now melt, and for many months have regularly melted, as a routine shop operation, titanium alloys into homogeneous ingots weighing 1,200 to 1,500 pounds. This is quite a decent-sized ingot, and it can easily be handled in all the conventional rolling and forging equipment of the average alloy steel mill. There is no longer any limitation on what size or shape of ingot can be melted, and this melting can be carried on with a surprisingly small amount of man power and at costs that are quite dramatic when compared to the effort and facilities required only several short years ago to turn out a few pounds of metal.

I do not have anything here about the ore resources, but there is much confusion about the sources of ore of titanium. Titanium metal comes from two types of ore. One is called rutile, of which there is a very limited supply. That is a natural oxide of titanium, perhaps analyzing as much as 90% titanium.

The other source, of which there is a much more plentiful supply is called ilmenite, and that is usually associated with iron ore.

In National Lead Mine, it is magnetite, or, in Kennecott & Serel in Quebec, it is hematite iron ore.

Whether it should be ilmenite or rutile, the ore when ground will look very black, just like this (*indicating*). Let us say it is rutile. It will be 90% Ti O₂ but still black. If we purify that and take out practically all the impurities, down to perhaps 90% Ti O₂, we would perhaps get the pigment which is the foundation of a very large industry in this country.

You notice we still have the titanium in the form of oxide, that is, combined with oxygen. And it does not like to give up the oxygen. That is what causes so much trouble in producing titanium metal. But we can take that pigment or that gem and can get the titanium metal. (*Applause*)

* * *

Chairman Macomber: Thank you, Mr. Lippert, for a very clear insight into the development of titanium on a commercial basis.

We shall leave questions until the end of the program. I believe we are on schedule, and we will have plenty of time after the talks are over for questions.

I would like now to introduce Dr. George Perkins who graduated from Purdue University with a BS degree in chemical engineering. He followed that with a PhD in metallurgy, physics, and chemistry in 1940 at the same university.

After four years as a metallurgist in the aluminum industry, he spent two years in Reynolds Metals in New York as technical adviser in the eastern sales division. In this connection, Dr. Perkins did special contact work with the General Electric Company in Schenectady, in developing new applications for aluminum.

In 1947 he was appointed director of technical services of the Reynolds aluminum sales division in Louisville, Ky. In 1950 he was appointed director of products and applications for Reynolds Metals Company, the position he holds today. It gives me a great deal of pleasure to introduce Dr. George Perkins. (*Applause*)

* * *

George G. Perkins: I appreciate your bearing with us through that long introduction. It certainly is not new for men in the metal industry to meet in the arena of calm competitive combat such as Mr. Lippert mentioned here, surrounded by people who are interested in seeing how we come out in that combat.

The debate on the relative merits of metals is probably as old as the metals themselves. It is, however, a little new for a representative of the aluminum industry to appear in a meeting such as this. Normally we are pitted against representatives of the staid old businesses: steel, copper, zinc, lead, tin, who are firmly defending their positions in the industry against this rank young upstart, aluminum.

Today I find myself standing here representing a staid, old business, aluminum, trying to stand up against these

rank young upstarts of titanium, zirconium, and cerium, and some of the other metals to be discussed by Dr. Lund.

The only other solution, as far as the aluminum industry is concerned, as far as I can see, is for us to continue to forge ahead. If we are going to talk about what is to be done with all this aluminum that is to be produced, let us take a quick look at how much has been produced and will be produced.

In 1920 some 138 million pounds of aluminum were used. In 1930, ten years later, there was an increase of 65%, to 229 million. In 1940 it went up to 413 million, another increase of 80%. Of course, 1950 saw the phenomenal increase brought on by World War II with a jump to, roughly, a billion and a half pounds, or an increase of some 265% during that decade.

Now, we look forward to the next ten years with a projected production capacity of some 3 billion pounds in 1960, a further 100% increase compared with 1950.

Where will all this aluminum be used? If we are to talk about where metal is to be used, we have to take into account certain factors. The ultimate cost of a metal used is governed by three things: (1) the price of the base material, (2) the fabricating cost, (3) the utility of the finished product. That is, will the finished product be better or poorer than the same product made out of a competitive metal? In other words, will it command a higher price, or must it be sold for a lower price?

When aluminum competes with steel, wood, and paper—and it does in many cases—we find that we are at a disadvantage in respect to the first factor; that is, the base material cost is higher.

In the second factor, that is, fabricating cost, we are usually at a par at least. It costs no more to fabricate the aluminum, sometimes less.

The third factor is the utility of the finished product. As far as utility of the finished product is concerned, we have the advantage in most cases.

It is in competing with the other metals, such as copper, zinc, lead, tin, that we find these factors quite reversed. In the base material cost, the advantage is very definitely in the favor of aluminum. In respect to the fabricating costs, we have many difficulties to overcome; and, using present techniques, many times we have higher fabricating costs with aluminum than with these other metals.

I am thinking of such things as the great difficulty of soldering aluminum compared with soldering copper. Then, it is somewhat more expensive to plate aluminum than brass or zinc because of lack of understanding of the proper techniques.

Third, as for as the utility of the finished product, we are usually at fairly much of a stand-off with respect to these other nonferrous metals.

SPECIFIC APPLICATIONS

So, let us take a look at some of the specific applications in which we foresee that aluminum will be used in 1960 but was not used in 1950. I think we can all agree that we had a fairly healthy industry in 1950, with some billion and a half pounds of aluminum produced and consumed before any particular defense effort. Let us let that healthy industry alone and look at this additional billion and a half

pounds of aluminum that will be produced in 1960 that was not produced in 1950, and let us see what we are going to do with it.

I am going to leave out of the discussion such things as cooking utensils and items that are standard, accepted practice, and so do not think that I am forgetting about those. I am only saying that those will use up 1950's aluminum.

Let us look at expansion. In the field of appliances and housewares; refrigerator evaporators, shelves, and pans; vegetable pans; and so on; they got a little start, surely. But we foresee that aluminum is going to replace a major portion of the tinned copper and tin evaporators and shelves. That alone would account for some 50 million pounds of aluminum per year.

In the heating field, we have convector-type heaters with aluminum fins. We are certainly going to move in on the copper fins, steel fins, and the old cast-iron radiators. Here we have another market for some 20 to 30 million pounds of aluminum.

In the metal furniture field, there has not been a growing demand for metal furniture, but we do not believe, particularly in the outdoor furniture field, that we are going to use much more aluminum than has been used in the past.

In the chemical field, we know of course that a good deal of aluminum pigment has been used, but most of it has been used on the outside of buildings, that is, in paints.

How about the inside? There is many times more area to be painted on the inside of a house or inside of a building than on the outside. Aluminum has never entered into that field.

New developments in pigments are going to make use, not only of the attractive qualities of such pigmented finishes, but also of the heat-reflecting properties.

A very interesting application of aluminum (it is anyone's guess to how far it may go, but certainly it seems to have military applications) is the use of aluminum as a fuel. I do not mean its use as a fuel container, but as a fuel to be burned. Aluminum, as we know, has one of the highest heats of combustion per pound of any material. Therefore, it is of very considerable theoretical interest for burning.

Such experiments, of course, are under way by the military at the present time, and we rule them out as far as our present discussion goes, but it is a most interesting application.

THE CONSTRUCTION FIELD

In the construction field, which has always been a big consumer of aluminum, one item alone, aluminum windows, has for the past few years consumed aluminum approximately at the rate of 100 million pounds a year. But that is only 12% of the window business in the United States.

What of the growing acceptance of aluminum windows, not only for homes, but for commercial and industrial applications? Certainly we can look forward to a two- or three-fold increase in that field, representing an additional market for 200 or 300 million pounds of aluminum.

Aluminum siding for domestic use has only started within the last two or three years to replace wood, not only for

new construction, but also for revamping old construction, with a baked enamel finish indistinguishable from wood clapboard siding a few feet away. We find that many millions of pounds of aluminum will go into that field.

Consider the new curtain wall construction that we have heard so much about. Aluminum panels replacing masonry construction would certainly see many millions of pounds of aluminum used.

Consider bridge railings and ductwork that received so much publicity a few years ago during the time of the galvanized steel shortage. We realized, of course, that much aluminum was used at that time when galvanized steel was hard to obtain, but it is amazing what acceptance has grown up for that product.

Aluminum scaffolding is another field. Scaffolds have to be moved around from place to place, have to be put together, taken down, reassembled. Aluminum scaffolding will certainly see several millions of pounds of aluminum used per year.

Aluminum hardware will partially replace brass and steel-plated material. As you know, the trend in building hardware is toward white metal; and the cheapest white metal to use is aluminum.

In the electrical and communication field, we see aluminum pitted against its old adversary, copper, of course aided by the depleting supply of copper in that field, ACSR.

Aluminum cable reinforced has been an old application for many years, but we will see aluminum moving downward in the voltage field, not only in the cross-country transmission lines, but in the distribution field within the city as well and, finally, into the covered wire and cable field and the building wire within your homes.

Magnet wire and motor windings is another place where aluminum is presently getting started, and we will certainly see more and more of it used there. All of the major electrical manufacturers have very extensive development programs under way, or are actually in production in the use of aluminum wire for motor transformers and magnet windings.

Some of you may have seen within the last year aluminum-base lamp bulbs. This is the outgrowth of a development program that started four or five years ago when brass was the standard material used for that. Now we see aluminum bases for lamp bulbs and for the sockets in the lamps into which they are screwed. Again, this is a market for some 15 to 20 million pounds of aluminum.

Aluminum busbar is presently gaining in popularity. There, of course, we have been faced with the problem of making joints not only of aluminum busbar to itself, but to other conductor materials. Now, General Electric, Square D and Westinghouse—all of them—are putting in installations of aluminum busbar with very satisfactory joining methods. It would seem to us that that should represent a market for some 40 million pounds of aluminum.

A rather interesting small application, from the standpoint of tonnage, but most interesting in its concept, is printed circuits. As we all know, for quite some time, the television and the electronics industry as a whole has been looking for some means or some improved method of getting away from the maze of wires and connections in its

very complicated circuits. It looks as though, by a combination of printing and etching methods, we may be able to utilize aluminum foil for such purposes.

We find increased interest in the use of aluminum for cable sheathing. Has it caught on much yet? In this country it has not. But in Europe, and England particularly, sizable quantities of aluminum are replacing lead for cable sheathing. We find there primarily a problem of extrusion presses utilized for applying the lead sheeting not being satisfactory for aluminum of conventional purity. We must either use higher-purity aluminum or elevate the temperatures, which means different insulating materials in the cables. However, we will certainly find aluminum taking the place of lead there in a gradual conversion program.

Another most interesting application is the possibility of aluminum for battery plates. There has been considerable investigation during the past few months into the attempt to get a longer-life, lighter-weight battery. It would seem that aluminum grid with pure lead plated on that grid has very interesting possibilities. The pure lead actually serves better as the battery plate, and gives a long chemical electrical life to the battery; because with the old construction one had to use lead to give it strength. Now, the aluminum core gives it strength, and pure-plated lead gives the functional properties of the battery.

There are a number of other fields. One is irrigation tubing. We have all seen the increase in demand. It certainly is going to expand widely.

Grain bins and utility buildings on the farm; aluminum gates are becoming quite popular on the farms, replacing old wood and galvanized steel.

Farm machinery is most interested in aluminum, not for the motor power, that is, the tractors, but for the vehicles pulled by the tractors—combines, harvesters, and so on—where the move is toward lighter weight, so that the machinery can get into softer ground and requires less power from the tractor. The major farm machinery manufacturers each have trial units of substantially all-aluminum construction now under test.

In the petroleum industry, we find a good bit of interest in aluminum, although not extensive applications as yet, with the exception of aluminum storage tanks. Within the last few years a number of aluminum oil lines, gathering lines, and transmission lines have been put in. Here aluminum has the advantage of much less expensive installation, particularly in rigorous terrain where it is easier to transport the light-weight pipe which has shown improved corrosion resistance against the sour crude oils.

In gathering lines where pressures are low, lightweight aluminum pipe is actually the least expensive to install—cheaper than the presently used standard-weight pipe.

In the petroleum and chemical fields, we have the most interesting application in the new oxygen plants which are becoming more and more popular across the country. Few people stop to realize that, at the temperatures at which those oxygen plants or certain parts of them operate, aluminum is the best structural material to use. Whereas other materials become brittle at the very low temperatures, aluminum becomes stronger and tougher, and so we find large quantities of aluminum used there.

Aluminum welding wire is a small application in itself, but important in that it is indicative of the amount of metal that is being joined together by welding. It would look to us as though next year somewhere between 5 and 10 million pounds of aluminum will be used in the form of welding wire. That means a lot of sheet and extrusions which are joined together by that wire.

A very unglamorous but not unworthy application of aluminum is for shovels, ordinary hand shovels. There, you find the kind of application we like to talk about, where aluminum is competing not against a more expensive material, but against a less expensive material: steel. But it justifies the higher base cost because of the greater utility, easier handling, and less work in using the finished item.

For lithographic plates, we find that, with aluminum, we get better impressions and longer life than with zinc plates.

In the packaging field, we find such things as drinking cups, trays, and pie plates, where intermediate gages of aluminum are used. I am thinking of the range of 004 and 008 material, which is used to create semi-throwaway items. For example, pie plates that may be used once or twice and then thrown away.

We find, in the field of cereal packages, particularly where some of these cereals require very low moisture-transmission rates, that aluminum foil is the only economical material for packaging those cereals satisfactorily.

TRANSPORTATION LARGEST METAL CONSUMER

I have left for the last the vast field of transportation, which is, of course, the largest metal consumer at the present time and therefore represents the greatest possibilities for the development of aluminum.

In the marine field, we find aluminum being used in tankers and especially in the lifeboats. But, most important of all, it is used in the superstructure of all types of ships in order to lower the center of gravity and increase speed and maneuverability.

Aluminum has always looked at the railroad field as a likely possibility. I do not see large tonnage uses there within the next few years. Sure, we have built aluminum freight cars, but we still cannot ensure the company who builds those cars getting its money back when the cars spend most of the time on somebody else's road. Perhaps some day we could have a sort of differential charge system that would return the money spent to the builder.

Refrigerator cars have been built, but probably the most fruitful field there is in the tank cars hauling specialized chemicals, such as ammonium nitrate which is becoming ever more popular in the fertilizer field. This year it looks as though some 500 tank cars will be built, each utilizing some 10,000 pounds of aluminum. That is not a field to be sneezed at, particularly since it would seem that ammonium nitrate will become more popular in the fertilizer field.

The truck and trailer field is becoming more and more cognizant of the fact that, if they cut down on their dead weight, they can haul more pay loads.

Side panels alone, where steel and wood have previously been used, will utilize between 15 and 25 million pounds of aluminum per year.

Aluminum wheels are fast becoming standard equipment on such large trailers, because strong weight, you know, is particularly important to them.

Extruded aluminum floors have come into existence in the last few years and are replacing wood and magnesium floors. That is one field we like to talk about, because it is a field magnesium jumped into ahead of us, and now it looks as though we are going to get it back again.

House trailers in the past have been primarily of wood construction. As they have come to be considered more and more permanent homes rather than just for traveling vacation use, aluminum becomes more important to them.

Then, of course, there is the automotive field, the glamor boy of all the metal producers. A great amount of publicity has been given to aluminum radiators recently. I am certain that all the major automotive manufacturers have one or another version of aluminum radiators out in test cars and have been doing this for quite some time.

The best indication I can give you that conversion has progressed is that tomorrow a meeting is to be held in Washington among representatives of the automotive industry, the aluminum producers, and NPA, to discuss their mutual problems.

Cast hardware on automobiles is replacing zinc die castings and cast iron parts. Certainly it looks like a fruitful field for aluminum. Here, of course, there are many parts where the conversion is moving rapidly forward. Such things as fuel pumps, oil carburetors, and oil pumps, are involved.

In the finished parts, where we have the problem of highly polished and highly decorative chromium plate, aluminum is a little further along, but all the car manufacturers have very positive programs under way for such parts.

The automatic transmissions, fast becoming standard equipment on all automobiles with only one exception, have substantially all-aluminum construction. The Buick Dynaflo is the exception.

Electric equipment on automobiles is certainly of growing interest to the aluminum manufacturers. The automotive electrical companies, again, have test parts out in all of the major components utilizing aluminum in place of copper.

I have not said anything in this discussion about the aircraft industry and would prefer not to for two reasons. The first is that we all are aware of the off-and-on nature of the industry. Second, there is no question but that there are many applications in aircraft where aluminum is going to be replaced by other metals, such as titanium.

Many people in the aluminum industry believe that it might be a healthy thing for the industry if we could become disconnected from the aircraft industry a little so that we would not have the rapid fluctuations in supply or in utilization by that industry.

It has been said by many people that aluminum becomes a religion to those in the aluminum industry. I should like to propose that at least in one sense there is a great similarity between the aluminum industry and religion. Many scientists, faced with certain facts against which they cannot argue, say that the existence of a higher order of

some sort becomes the most logical conclusion to draw. I cannot stand in front of you today and prove to you that every pound of aluminum that is going to be produced in 1960 can be consumed by commercial enterprises. But I think, faced by the relative certainty of these tremendous applications that I have listed here very briefly for you, the fact of an assured market for aluminum becomes the most logical conclusion to draw. I thank you. (*Applause*)

* * *

Chairman Macomber: Thank you very much, Dr. Perkins, for your excellent and detailed analysis which goes a long way toward answering the question about the large expansion now going on in the aluminum industry.

Last but not least in our New Metals Forum, I would like to introduce Dr. Richard Lund. On his broad shoulders falls the rest of the new metals to be discussed. There are many of them. They are varied.

Dr. Richard Lund is a graduate of the University of Wisconsin where he studied geology and mining and metallurgy. He received his BA in 1926, his MA in 1928, and his PhD in 1930. He was with the WPB in charge of miscellaneous minerals during the war.

He was with Reynolds Metals for over one year. After that time he joined the Battelle Memorial Institute where he has been for six years supervisor of engineering and economics. It gives me a great deal of pleasure to introduce Dr. Richard Lund. (*Applause*)

* * *

Richard J. Lund: Mr. Chairman, ladies and gentlemen: When Mr. Macomber called me a couple of weeks ago, his assignment was quite indefinite. He said, "Oh, Mr. Lippert is going to talk on titanium, and Mr. Perkins is going to talk on aluminum." Somehow or other I thought he was going to talk on magnesium, but Mr. Macomber said, "Oh, talk about beryllium, cobalt, cerium, or some of these others—you know." Well, it was only a half hour ago when I arrived today that I found out that Dr. Perkins was not going to talk about magnesium.

MAGNESIUM

Certainly if we are talking about new metals, we cannot neglect magnesium, so I am going to stand here now and talk a little about this metal. I will speak extemporaneously perhaps for just a couple of minutes on magnesium, because it is certainly one of the growing metals that we are going to have to watch very carefully in the future.

After the wartime tremendous upsurge in capacity for the production of magnesium, a lot of those wartime plants—I think it went up to close to 200,000 tons, or 180,000 or 185,000 tons annual capacity—of course, were put in standby. Some of them were actually torn down or converted to other uses. But many of them were retained in standby condition. It was about a year ago that the Government decided they were going to put those back into shape, which they have been doing. I understand that all of those, I think five or six, plants are now back in operation, and by next year we should be producing again and may be producing at a capacity that is about eight times or seven times the 1950 production.

The 1950 production is about 15,700 tons, I think, of primary metal, all of which came from the one seawater plant which is the electrolytic plant of Dow's at Freeport, Tex.

These other plants will add something of the order of 98,000 tons per year capacity. Many of them are high cost, yes. I do not know what the figures are, but it may be almost double in cost, or it may be even better than double the cost of producing from, let us say, Dow's Freeport plant.

Some of them have the so-called "pigeon" process, which makes use of ferrosilicon to reduce the magnesium that occurs, rather than seawater extraction electrolytically. That is a batch process.

If that particular process can be perfected to a continuous process, there is a good chance of lowering costs.

A couple of these plants that have gone back into operation are electrolytic plants.

Another very important development in magnesium, to me it seems, is the construction of a continuous mill by Dow in Madison, Ill. This is certainly going to make a lot of difference in the price or cost of magnesium sheet. This is one of the important elements that has held back the much greater use of magnesium in the past: the relatively large spread between the price of magnesium in ingot form and the price in semifabricated form—sheet castings and so forth.

This continuous mill is certainly going to make a substantial difference. The capacity of the mill, as I recall, is something in the order of 3 million pounds a month, which is close to 40 million pounds a year, compared to the capacity for making sheet, without that mill by the old hand methods, of something in the order of 3 or 4 million pounds a year. I think those figures are approximately right. So that we can certainly look forward to a continuing healthy expansion of magnesium in the next decade. Certainly the metal is available in seawater—unlimited quantities.

The only really critical item that is involved in converting it is power, just as with aluminum. So much for magnesium. If I am going to say much more about any of these others or even hit the high spots of a few of these others, I think I will have to leave magnesium with that.

When it comes to these other metals, we simply assume that the old standbys of copper, lead, zinc, and tin are not new metals. I think perhaps most of us will agree that they do not nearly have the growth potential for expansion in the future that the newcomer, titanium, has, and the relative newcomer—I think we can call aluminum that—and magnesium.

They will probably do a good job if they hold their own at approximately the present levels even for the next decade or several decades, with the likelihood at least that worldwide supplies are going to become scarcer and scarcer—and actually they may start tapering off.

Therefore, if we cast those aside as nongrowth metals, as metals without that growth potential, I want to give just a few minutes to some of the metals that we have previously grouped into what was known as the ferroalloy group of metals: manganese, chromium, nickel, tungsten,

molybdenum, and so on, that have been in the past, as I say, associated pretty closely with steel; and they will be in the future connected closely to steel.

Chromium and nickel, especially, are in a somewhat different category, because they are allied so closely to stainless steel; and these high-alloy steels such as stainless have seen growth in the past decade that is far out of proportion to the growth in tonnage steel. Just postwar, I think, a good year of stainless was a half million tons. Now, we are getting pretty close to a million tons of stainless, with the likelihood that the figure will go up. Stainless means nickel and it means chromium, so that nickel has had a job to keep pace with that advance.

In addition to that advance, these metals—not only nickel and chromium, but molybdenum and tungsten and cobalt—have had another major development affect their requirements: namely, the gas turbine and the jet engine developments.

There is a need for metals that will withstand these very high temperatures that even titanium or, of course, aluminum cannot begin to meet, and that even stainless cannot meet. To obtain metals that will withstand such temperatures, we must use no iron in them, or else virtually no iron or very small amounts of iron. That means metals that are composed mainly of chromium or of nickel or of cobalt.

Many of them have very high percentages of cobalt, and that is why cobalt was one of the earliest metals in the field that required close control.

Columbium, another one, I think was the first that went on allocation solely because of the jet engine cobalt.

Another major development that has focused attention on a lot of these minor or lesser-known metals is the old field of electronics, television, and radar, where many of these metals can do a job that nothing else can do. It involves relatively small amounts. We are not talking about big tonnages here, but of poundages, thousands or hundreds of thousands of pounds altogether in many of these metals of minor nature. But this has been very important in focusing attention on such metals as, for instance, germanium that we have begun to hear so much about in the last year or so.

Another major development, of course, is the atomic energy program. That has focused attention on a lot of these minor and lesser-known metals, either because we consider uranium and its use in the nuclear energy program itself, or because of their importance as construction materials in connection with these plants.

In that connection, zirconium might be mentioned and also beryllium. We all know that the interest in a lot of metals of that type has been given great publicity.

Perhaps rather than try to cover a few comments on a lot of these metals, I might just select a few. First, I would like to say just a few words about a few of these ferroalloy metals which I mentioned just a few minutes ago. I might say, before I start, that, when we are talking about these minor matters, we must consider, of course, that we are interested in growth potential. There may be tremendous demands for these that would permit large growth potentials. There may be very interesting properties that would

account for these large demands. But in many cases we just cannot see the supplies to meet these increased demands involved in rapid growth potentials.

Nickel, for instance, certainly has a tremendous potential in demand, but the supplies are just not readily available, at least at the present time. Roughly, now, 80% of the world's nickel is tied up in Canada. The expansion takes a tremendous amount of effort and many years to increase the capacity.

Perhaps the big opportunity for nickel in the long-term future is involved in the lower-grade ores such as silicate deposits in various parts of the world, and in low-grade laterites that contain not only nickel but much more iron and characteristically also chromium and some cobalt.

Probably in the long-term future, the major potential for nickel expansion lies in the development of a satisfactory process for treating those lateritic ores to recover the iron and the chromium and the cobalt that characteristically occur with those ores.

Cobalt has this tremendous growth potential, too, so far as demand is concerned, but, again, the supplies are not available, except in moderately increased quantities, to meet this large demand.

Skipping over to some of the lesser-known metals, we find again a group that will not be involved in tonnage developments, but they will serve very importantly in lesser quantities to do a given job better than metals that are available or materials that are available at the present time, or to do a job that materials at the present time are unable to do.

The mineral zirconium in the past has been used mainly in the field of refractories and ceramic applications. However, coming along with titanium, it has many properties quite similar to titanium. It has the same difficulties of processing and converting from the mineral to the metal. It combines identically with oxygen and other gases, so that whatever process is worked out for titanium may have an application to zirconium.

In other words, as the research goes into the perfection of processes for the recovery, cheaper manufacture, and cheaper conversion of the ores to metallic titanium, zirconium generally may benefit from those developments.

Zirconium's potential applications are tied up mainly in the chemical field probably. Its resistance to corrosion is much better than that of titanium in certain fields, for example, in the field of resistance to hydrochloric acid concentrations in various concentrations.

In that respect, it is quite comparable to the metal tantalum. When quantities are available in greater amounts, we will probably see zirconium taking the place of tantalum in many uses. Also it has been given important consideration by the Atomic Energy Commission because of its properties as a material of construction in various equipment pieces used in the atomic energy program. It is available in moderately large quantities in this country. It occurs characteristically with certain types of titanium deposits—ilmenite deposits of the beach-sand type.

Next, Mr. Macomber said you would probably be interested in hearing at least a few words about cerium, the rare earth mineral. This has had quite a ride in the last few months. The mineral, of course, that provided us

with most of our cerium and rare earths in the past was monazite, a phosphate of the rare earths. Most of it came from India and, secondarily, from Brazil.

India slapped the embargo on because, of course, monazite carries characteristically from a few per cent up to probably 10% of thorium oxide which, of course, is of interest in the atomic energy development because of its radioactivity.

India slapped the embargo on, and it stopped exports. That was probably four or five years ago, but the supply has continued to come out of Brazil until those were shut off earlier this year, which left to us the job of developing our own resources.

This scarcity, of course, was reflected in price, which increased about six or seven times, and we found some very substantial deposits of monazite in various parts of the country. Of course, we have known about a lot of monazite in the Carolinas for many, many years. That provided our output back at the turn of the century. We produced quite a bit of it. Idaho certainly is a potential producer of very substantial quantities of monazite.

Even preceding that development came the discovery of this new mineral, a very rare earth mineral, bastanzite, in California, and another one which was discovered even earlier in New Mexico which accompanied a fluorspar deposit out there. It was explored by the Bureau of Mines quite carefully during World War II, back in 1943, because of its fluorspar, but they recognized that the occurrence of this mineral bastanzite is a fluocarbonate of these rare earths.

The California development has received most publicity and interest, and certainly out there they have a tremendous tonnage. It is a unique deposit. Nothing like it has ever been known in the world, and it is right on the surface. It can be mined, quarried by open pit. Apparently, the problem of concentration of it and separation of the bastanzite from barite—barite occurs with it out there in about equal quantities as a rule—and calcite has been solved.

So, there is a tremendous potential, between the bastanzite deposits and the monazite deposits that we have discovered. We are certainly and surely self-sufficient. We can produce what we need, although it will be at higher prices, I am sure, than we have been paying in the past.

One important factor that has really limited the application and the demand for this material in the past, these rare earths—zirconium and other metals—has been the limited supply. There has always been the fear that, if we develop new uses, will we be able to get enough of this material to satisfy those uses? That fear certainly should be squelched in these future developments.

One major factor that should be kept importantly in mind in considering the bastanzite development is that the bastanzite does not carry recoverable quantities of thorium oxide.

If the Atomic Energy Commission or, in fact, if atomic energy developments should require greater quantities of thorium, it simply means that a considerable amount of monazite is going to be produced to supply the thorium, and that cerium and rare earths will be produced from the monazite.

There are indications, so far as demand is concerned, that important metallurgical applications will require substantial tonnages of this material, both in the field of magnesium alloys and in the field of stainless steel. Those have been discussed, and a lot of publicity has been given them. Other applications involved in other types of steel are concerned with defense applications that we cannot discuss. But the potential in the metallurgical applications is substantial.

DIDYMIUM

There is another potential field in the scarcity of selenium which in the past has been used in rather substantial amounts in decolorizing glass. Apparently, the best substitute for selenium is didymium, which is one of these rare earth metals. In fact, it is a rare combination of a couple of them, and that has potentialities. We have not explored that. I do not know just how far they can go in paying for this material, because it is an ore costing several dollars a pound.

There are other potential uses in glass that look attractive, so that there seems to be a potential for substantially increased quantities, otherwise, for the rare earths involved in this bastanzite development.

Of course, the old uses were flints for cigarette lighters and for carbon arcs used mainly by the movie industry. In those fields they are looking toward increased usages. I find that in just discussing these two, in addition to the magnesium comments, I have apparently consumed my time. (*Applause*)

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Chairman Macomber: Thank you very much, Dr. Lund. You have honorably discharged your great load.

We have approximately twelve minutes left for questions.

Mr. Wilson: As I understand it, the present production of titanium employs the coal process which results in a cost of something around \$5 a pound. Has there been any improvement by your company or by anyone else recently that has significantly reduced that cost and, if so, to what extent?

Mr. Lippert: The titanium until very recently has been made in very small reactors. (*Remainder of Mr. Lippert's remarks inaudible.*) There is a great deal of room for very drastically reducing the cost of titanium within the coal process.

Mr. Wilson: By making it a continuous process?

Mr. Lippert: By making it continuous. (*Inaudible*) And by certain different transitions from the raw product to your ingot metal.

Mr. Rayvad (Hirsch & Co.): I would like to ask Dr. Perkins how much aluminum metal goes into an automobile radiator.

Dr. Perkins: It depends on the type of construction. There are two general types being worked with at the present time. One is the all-aluminum construction that has both aluminum fins and aluminum tubes that require about 15 pounds of aluminum. There is another type under consideration, a composite metal with brass tubes and aluminum fins, that would require about half that amount.

John Newbold (W. A. Newbold & Son, Philadelphia): I would like to ask Dr. Perkins if he has any idea of the relative cost of delivering a pound of aluminum, a finished aluminum product, to the New York market, or the difference between his cost and, say, that of the Aluminum Company of Canada? That is a rather unfair question, but I wonder if you have any ideas on it.

Dr. Perkins: I think you fellows have probably supplied just as good answers to that as the aluminum industry has in some of the surveys that have been made in the aluminum industry. I believe you are all familiar with the very low-cost plants that are available in Canada; and the results of that are common knowledge. There is no question but that they have plants which can produce aluminum somewhat cheaper. Now, whether that is one cent or two cents depends a lot on how you figure your amortization costs. But they have lower cost-producing plants than anything in the United States.

Chairman Macomber: We have a new twist here. We have a question from one of the guest speakers to one of the other guest speakers.

Dr. Lund: I would like to ask Dr. Perkins if there is not one other use of aluminum that I think he did not mention, which might involve very substantial tonnages in the future: namely, aluminum-coated steel as a substitute or a competitor for galvanized steel.

Dr. Perkins: I appreciate the help from our competitors here. There certainly is a tremendous potential there; and what it is I do not know. It will depend on the relative costs of producing that product versus galvanized steel. Frankly, I do not think we are far enough along in the industry to know what those are going to be.

There are really two possible methods of making such a product. One is by a hot dip, that is, immersing your steel in a molten aluminum bath; but then we produce a product that has all the inherent disadvantages of the hot dip galvanized.

The method of producing such a product that we believe has great possibilities is by cladding the two, that is, by taking a sheet of aluminum and a sheet of steel and rolling them together in proper proportional thicknesses, whereby we obtain a much more useful product. But just what its costs will be we are not yet in a position to say.

We have done pilot plant work with such a product and have submitted samples to a great many people, but certainly Dr. Lund is correct in that that product is going to see a great deal of use in the future. How much? I do not know yet.

Harry Thompson: May I ask Dr. Lund if he has any ideas on the world supply of beryllium and whether any new sources have been discovered recently?

Dr. Lund: Beryllium is the one I wanted to comment on briefly. To illustrate again a metal that has very large potentials, beryllium has very interesting properties, light weight, and a very high modulus of elasticity, which make it a very interesting structural material. Of course, it has very interesting electrical properties, too, and workable properties, but we just have not got enough of it.

It occurs in pegmatites. A good beryl pegmatite will contain around 1% of the mineral beryl, which is a beryl-

limum aluminum silicate; and that mineral beryl will contain, on the average, only around 5, 6, or 7% of Be, beryllium. So that, actually, a ton of pegmatite that you have to mine may contain only about 1 pound of beryllium. Therefore, the problem of by-products is one that may be whipped eventually, the problem of recovering this beryllium by mechanical means.

So far, it has not been successfully done. They still have to hand-cob, chip that beryl out of the deposit by hand virtually, and separate it. A lot of deposits are known. A lot of them are in Canada. We have some of them in the United States.

The Kings Mountain development in North Carolina, incidentally, is another one I wanted to comment on briefly, as it relates to lithium, which is another mineral that I think has interesting possibilities. Again, there are relatively small quantities, but it has interesting growth potentials.

Beryl might be recovered down there along with lithium, and there are also columbium and tantalum. Particularly columbium in this jet engine program characteristically occurs in very small quantities in these pegmatites, but they have not found anything—in reply to your question—that is really big as raw material sources for beryllium.

Question: Mr. Lippert, assuming total sales of 100 million of titanium next year and a probability that Titanium Metals will be one of the leading producers, will you hazard a rough guess as to what percentage Titanium Metals might account for?

Mr. Lippert: We will account for approximately 75 million.

Mr. Ferguson: I would appreciate from Mr. Lippert a comment on the story you have seen in the newspapers about a rival titanium company being able to produce it at a cost of \$1 per pound or less, and what possible method they could have that would provide them with that cost figure.

Mr. Lippert: Horizons Incorporated is a very good research outfit. Their headquarters is in Princeton, and their laboratory is in Cleveland. They have done very good work in research, just as have our esteemed friends and National Research.

During the war I think they had a research contract on electrolytic zirconium, and I believe this work with the Navy is an outgrowth of that, probably to arrive in electrolytic titanium.

I think that Horizons was somewhat embarrassed by the announcement, and I have never had Horizons' officials intimate that they would guarantee to get that price. They only made a few small buttons of electrolytic titanium, and we have made hundreds and hundreds and hundreds of pounds of electrolytic titanium and melted it and forged it. However, still we are not confident of our process, and we think it will probably come, but not for several years.

You can never tell. Maybe Horizons will come up with the ideal process, but we have made much more and still we aren't . . .

Chairman Macomber: I am very sorry to have to cut this short. I want to thank the speakers here today for their excellent presentations. (Remainder of chairman's remarks inaudible.)

Current Developments in Railroads

THURSDAY AFTERNOON, NOVEMBER 8, 1951

PIERRE R. BRETEY of Baker, Weeks & Harden presiding.

Chairman Bretey: It is a pleasure for me to welcome you here to the railroad forum of the Eastern Regional Conference.

I might say that the genesis of this railroad forum arose from my reading of a very interesting editorial in the *Railway Age* of October 1, 1951, entitled "Dogma versus Reason in Regulation of Railroad Trucking."

IMPORTANCE OF TRUCK COMPETITION

Because of the importance of truck competition in adversely affecting railroad profits, it seemed peculiarly fitting that we should turn our attention to this problem, especially as in our previous railroad forums speakers did not emphasize trucking as a competitive factor in the railroad picture.

Our first speaker was to have been the writer of the editorial previously commented on. One paragraph therein stood out: a summary of a trucker's opinion relative to train versus truck competition. It is so significant that, with your permission, I would like to read it to you.

Given equal rates and even fairly comparable service, shippers prefer the rails, especially the smaller shippers and those in smaller towns. They like to have at hand an established local agent on whom they can call for authoritative information. They like to deal with an agent, not with a driver who is always in a hurry to get out of town. They don't like to have freight dumped on them in the middle of the night. Things in my territory are at such a state that, if a railroad should tie in a good tight truck operation with fast rail service to break bulk points, it will capture the business—even at rail rates.

A person who can capture the spirit of one of his competitors to that degree has something very definite and concrete to present. It was for that reason I asked William Schmidt, the western editor of *Railway Age*, to join us. Unfortunately, Mr. Schmidt was unexpectedly called to the West, but his associate, Major Hudson, is here to read his paper.

Mr. Schmidt has told me that the major is at least equally qualified to answer any questions you might have, even though he might be a little bashful in admitting it. Major Hudson is the news and financial editor of *Railway Age*. And so we give the podium over to you, Major! (*Applause*)

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G. C. Hudson: Mr. Bretey and gentlemen: When I last saw Bill Schmidt last Saturday he asked me to express to you his apologies and regrets because of his inability to be here. I can assure you that no one in the room is any sorer than I am personally, especially in view of Mr. Bretey's reference to the questions that may follow. I might add that I also would like to trade places with Bill for another reason, which is that he is presently either on, or on his way to, the Pacific Coast.

He has given me this paper and we have been over it together. I am going to read it, except for one or two last-minute insertions, exactly as he prepared it.

AN IDEAL TO STRIVE TOWARD

For many years co-ordination of the various forms of transportation, so that the public might take joint advantage of the best qualities of each, has been put before the carriers as an ideal toward which they should strive. Economists, politicians, planners, and Government regulators themselves have preached the gospel of co-ordination to the point where the subject is hackneyed. Every dissertation dealing with transportation in glowing generalities winds up with a final benediction wherein magic co-ordination solves all the problems and pressures in the transportation business. You have heard the subject ad nauseam.

FRUSTRATION OF CO-ORDINATION

I would, therefore, hesitate to add to the toll of monotony except that there exists today a frustration of workable, practical co-ordination by the railroads which arises entirely from doctrinaire notions held by a persistent group within the Interstate Commerce Commission. It will be my purpose to demonstrate that the restrictions imposed as a result of this junto's dogma—aside from being unfair to the railroads—work against the interest of the shippers, especially in small towns; prevent good railroad less-carload service; defeat the long-accepted aims of co-ordination of the various forms of transportation; and, surprisingly enough, affect adversely the independent trucking industry itself, the national spokesmen for which are the cause of the frustration in the first place.

Except for that last, the public is in favor of use of motor trucks by the railroads as a means of cutting costs and improving service. Take, for example, the 13 regional shippers' advisory boards, established about the country as a medium by which the railroads' freight customers can, face to face, in open meeting, "advise" them what they need in the way of service. I read the proceedings of most of the meetings of these boards. Hardly a session passes without a recording of the fact that some member either praises a railroad for having initiated or expanded its motor truck service or, conversely, raises Cain because more roads have not done so. Use of trucks in auxiliary service is, in a sense, a hallmark of the progressive railroad.

HAVE NOT NEGLECTED THE FIELD

There is no doubt that the railroads themselves have not neglected the field. Today most of them are engaged in the highway movement of less-carload shipments in one form or another, although there is great divergence among the separate companies in the extent of that use. The latest complete study of motor operations by or for the railroads, based on the year 1944 and issued by the ICC in 1948, shows that, even then, for every 10 miles accounted

for by a railroad car hauling less-carload shipments, more than 8 miles were run off by a truck operated by, or in the direct interest of, a railroad. Today, the truck ratio is probably substantially higher. If you want to see how widespread is the over-the-road trucking of railroad freight, take a look at the so-called "National Substituted Freight Service Directory no. 1-E" (L. E. Kipp, agent, identified as ICC A-3576), which lists the railroads (and a few water carriers) that use substitute service by motor truck and also the truck operators (including railroad subsidiaries) that perform it. The directory is issued because the substitution would have no legal status otherwise. The theory seems to be that the shipper who gives his freight to a railroad must be put on notice whenever his stuff is moved by truck in part. The tariff specifically notes that the shipper "may direct otherwise." I have never heard, however, of a shipper objecting to co-ordinated service; he would have to have a very complicated brain to do so.

COMMITTEE ON MOTOR TRANSPORTATION

The current importance of co-ordination is indicated by the fact that the Association of American Railroads has recently formed a committee on motor transportation to deal with use of trucks and buses by the railroads. Some years ago the Association had a motor transportation division, with the dual function of considering trucking by the railroads and also keeping its eye on the doings of their competitors. The latter function has now been assumed by a new competitive research group with the AAR. The committee on motor transportation, it is believed, will stick to co-ordination matters. But its chairman, E. R. Feldman, is the same man who is currently heading up the competitive research program. Someone has suggested that this identity of leadership reflects the fact that the best way to lick one's competitors is to go into their business.

MORE THAN A CUTE APHORISM

This is more than a cute aphorism. There is no doubt that the practical knowledge gained by a railroad through experience with the trucking of its less-carload shipments better fits it to deal with its chief competitor for all traffic—the independent motor carriers—in rate making and service, and to seek to remedy the inequalities from which the railroad suffers. My own observation is that the railroad officers who know the most about the weaknesses of their competitors and what must be done to exploit them are those running companies notable for their interest in co-ordinated trucking. At the same time this knowledge enables them to avoid hysterical, indiscriminate fear of further diversions to the trucks. Practical experience in trucking, on the contrary, gives them a kind of confidence in the ultimate public acceptance of the advantages of what the railroads offer.

ADVANTAGES OF CO-ORDINATED SERVICE

The economic advantages of truck movement of less-carload freight, in lieu of movement in trains, have been cited many times. They include:

1. Substantial direct savings to railroads in operating costs, by eliminating overtime on local freight trains and

penalty payments to crews and, in some instances, the employment of extra crew members.

2. Substantial indirect savings from reduction of freight car miles.

3. Reduction in yard switching.

4. Fewer cars that must be cleaned and repaired to render them suitable for merchandise loading.

5. Reduction of freight house handling.

6. Greater utilization of freight houses at big points, built to handle large volume efficiently, and less handling at smaller points.

CONFER AN INDIRECT BENEFIT

These savings confer an indirect benefit on the public because they help preserve the railroads' financial health and ultimately affect the rate level. Directly influencing shippers are the service advantages of co-ordinated truck service, which, in the opinion of many railroad officers, outweigh even the savings in expense to the railroads. These service improvements stem from the fact that the wholesale carrier, the railroad, cannot do a good job where volume is lacking. Train service to and from smaller points is bound to be slower and more infrequent than service by the retail carrier, the motor truck. Whenever a railroad manages to establish a new co-ordinated service, increased patronage of the railroad lcl service usually follows, regardless of how the railroad rates on which it moves compare with those of the independent truckers. This indicates that the shipper needs and, is willing to use, better service. So much for the advantages.

POSSIBLE TYPES OF CO-ORDINATION

The possible types of rail-truck co-ordination cover many combinations. Thus, the trucks may be operated by the railroad directly (uncommon), by a wholly owned motor carrier subsidiary of the railroad, by the Railway Express Agency, by an outside trucking company in which the railroad has an interest, and by an independent trucker. The 1944 study cited showed that, on the basis of truck-miles during a test week, wholly controlled trucking subsidiaries accounted for 68% of the truck service performed on behalf of railroads, noncontrolled independents accounted for 20%, and operations direct by the railroad for 12%. The service rendered by the trucking operation may be limited entirely to substitution for train service—that is, less-carload freight which is billed via rail, moves at rail rates, and usually moves in part by rail. This type of service is the most common, under existing restrictions. It is what the ICC would like to limit the railroads to. But it is also feasible and economical to carry freight at all-motor rates, on motor bills of lading in the same vehicles, and on the same runs with the rail-billed and rated freight. Railroad express—and even mail—might be carried, and is, in some instances, on the same truck with freight. Now that the shippers, the ICC and the Department of Agriculture, among others, are admonishing the railroads to get rid of unprofitable passenger train service (as though they have not been doing their best to do so for many years past), there is clear need of untrammelled substitute motor service for the head-end business which has been carried on the losing trains. A good co-ordinated truck service already

established for freight is the best medium by which to handle it.

LOCAL PICKUP AND DELIVERY

Use of trucks for local pickup and delivery of rail shipments is also an important example of rail-truck co-ordination. Since, however, this terminal service may be performed without a certificate of convenience and necessity, and is regulated loosely under part I of the Interstate Commerce Act (relating to railroads) rather than under part II (relating to motor carriers), it needs no discussion here, except for the comment that a number of railroads believe that a railroad-owned agency is preferable to a contractor for performing local drayage, and that the best way to provide a railroad-owned agency for the job, without incurring heavy extra costs, is to use a railroad subsidiary already set up to haul freight over the road.

CO-ORDINATED SERVICE FOR PASSENGERS

Co-ordinated service for passengers is not a live subject today. Two decades ago some railroads went in heavily for stock ownership in bus companies. A few still own and control direct subsidiaries. Others sold out their interests in whole or reduced them below the point of control, chiefly when the price became right as a result of the prosperity of bus transport during the war. They found that their interest in bus lines accomplished nothing in the protection of rail passenger revenues, that their ownership merely handicapped their affiliates in dealing with independent bus lines on through routing, and that services in substitution of trains could be handled by contracts with independents, to which the railroad guaranteed revenues on runs that it required. Substitution itself is unpopular. Today, when a route becomes hopelessly unprofitable, a railroad wants to take off passenger service and be done with it. Thus, although bus operations in which the railroads are interested financially are by no means negligible, co-ordination for passengers is not a prime concern of railroad management today.

In this connection, attention is directed to the remarkable contrast existing between the ICC's grant of almost complete freedom to the railroads in the ownership and acquisition of bus lines and its restrictions on their participation in trucking. One would imagine that the ICC would have had to be more consistent, since the law makes no distinction between ownership of vehicles for passengers and those for freight. Could it be that the Commission substituted its own policy for that of Congress, in some mistaken notion that it was bound to protect the "small" trucker against the railroads, whereas the giant combines in the bus business—like Greyhound—could take care of themselves?

DEVELOPMENT OF REGULATION

The first experiments with trucking of railroad less-carload freight over the road, in substitution for "pedlar" freight trains, were carried on by the Pennsylvania and the New York Central in 1923 and 1924. The practice grew steadily. Most of the roads used independent truckers as contractors. The first railroads to form motor truck subsidiaries were the Great Northern; New Haven; Colorado

& Southern; Boston & Maine; and the Spokane, Portland & Seattle. By 1926 almost 4½ thousand miles of truck route were operated in behalf of the railroads.

Until motor trucks came under Federal regulation in 1935, use by the railroads of this form of transportation was not regulated, except for intrastate shipments in a few states. After the Motor Carrier Act went into effect, the Commission granted blanket, but temporary, permission to the railroads and motor truck contractors to continue the arrangements in effect, until their lawfulness could be ascertained. This permission lasted until 1939, when the ICC ruled that substituted service must be published in a special tariff (accomplished in the Kipp publication referred to) and that the truck operation must be covered by a proper certificate of convenience and necessity, held either by the railroad or by the company performing the trucking service.

MOTOR CARRIER ACT OF 1935

Under the Motor Carrier Act of 1935 (or part II of the Interstate Commerce Act), every common carrier by truck must possess a certificate from the Commission, granting him rights between given points and over given routes. All of the truckers who could prove they were operating in bona fide common carrier service as of July 1, 1935, automatically received a certificate, under what was euphoniously called "the Grandfather Clause." Those railroad-owned trucking subsidiaries that qualified under this clause thereafter possessed full rights as motor common carriers, and do today—but only on the routes that were then in operation. Thus, a number of railroad trucking subsidiaries have full rights to carry motor-billed and rated freight—including truckload shipments—in the same trucks with railroad freight on "grandfather" routes but must restrict their lading to railroad lcl for interstate movement on routes acquired since 1935.

THREE WAYS TO EXPAND

From 1935 on the railroads had a choice of three ways in which to expand co-ordinated, over-the-road trucking service. They could use an independent contractor, having the necessary ICC route rights, and pay him to move railroad less-carload freight in substitute service. Some of them use this method today, especially for new operations, because it does not involve the railroad's acquiring operating rights.

But this avenue is not an escape from the Commission's policy of restricting railroad rights, because the use of an independent contractor has serious disadvantages. First, the contractor's service is more likely to cost the railroad more money than its own, because he needs a profit, whereas the savings to the railroad resulting from reduction of local freight train service would justify a break-even operation by its own subsidiary. Furthermore, if the contractor holds the certificate rights, once the railroad comes to depend heavily on use of his service and adapts its co-ordinated handling facilities thereto, he is in a position to put on the squeeze for more money, out of proportion to any real increase in his costs. Actually, a railroad has no way of knowing what costs a contractor really incurs on its account alone, because unit costs depend on the whole of his operation. Thus, he may be using excess profits from his

service for the railroad to finance expansion of his other operations, which are in competition with his client or with other railroads.

LET IN ON THE GROUND FLOOR

Second, the independent contractor is let in "on the ground floor" of the railroad's traffic clientele. He sees who is shipping what where. If, as is usual, he pursues activities other than that of hauling railroad freight, he is under constant temptation to divert the shipments to his own channels. The impossibility of working with a contractor who has his own fish to fry is the reason why railroad companies cannot use general intercity highway truckers to perform their local-store door-delivery service, because his drivers actually see the freight on the shipper's or receiver's loading platform and are in a position to say to his personnel: "Why don't you let us take that instead of the railroad." One large cartage company—which for years traditionally has held a contract for delivering practically all railroad freight in one of the large cities of the United States—recently lost that contract because he had gone into the over-the-road trucking business on his own. Since most certificate holders will not agree to work exclusively for a railroad, it is obvious that use of independent contractors is fraught with danger.

Finally, the efficient use of motor trucks by railroads demands that there be as little duplication of facilities between rail and truck service as possible. Railroads have enormous investments in stations, transfers, and communication facilities. They employ resident agents, even in small towns. Indeed, these fixed facilities are the chief advantage they have over the ordinary motor carrier and are the reason why shippers in certain situations prefer to deal with railroad companies. Use of a controlled subsidiary, makes it possible to use these facilities in common, subject of course, to proper bookkeeping charges so that the truck subsidiary helps support the expensive railroad plant and does not have unfair advantage over competing independents. Use of independent contractors, on the other hand, makes the common use of facilities and personnel more difficult and/or throws the entire burden of their support on the rail side of the operation.

INDEPENDENT CARRIERS NOT AN OUT

It is clear that use of independent contractors is not an "out" for the railroads, to escape from the frustrations of the ICC's restrictive policies.

Since the major purpose of the Motor Carrier Act was to prevent cutthroat competition and insure responsible carriers, the ICC has not been liberal in handing out certificates to new entrants into the common carrier field on routes that it believed to be properly served. Hence, with the passage of the act, railroads seeking rights as motor carriers believed it might be easier, on routes already well served by truck, to purchase existing carriers. This would give them not only some equipment, personnel with operating "know-how," public esteem built up by the independent, and better relations with connecting motor carriers, but also their certificate.

In the first railroad acquisition case that came before

the Commission (the so-called Barker case, decided in 1937), the ICC ruled that permission to buy would be on condition that the service be auxiliary of, and supplemental to, the railroad service of the carrier. Some 40 other acquisition cases were decided on this precedent before 1940. All except three decisions, however, included a reservation of authority to impose further restrictions later, as might be necessary to limit operations to those connected with railroad service.

Starting 1940, and beginning with the so-called Frisco acquisition case, the practice of specifically reserving rights to impose additional restrictions later was not followed. There also developed a tendency in the Commission's decisions to treat the Barker case restriction of "auxiliary" as geographical only, rather than as a substantive limitation on the character of the service that might be rendered by a railroad or its affiliate. In short, the railroads and the Commission too (although it has since denied any such intent) came to regard the condition as prohibiting only trucking operations by railroads that go beyond the areas served by their rails (except in substitution for abandoned lines). Since railroads, in general, are opposed to invasion of each others rail "territory," the condition, as interpreted, was not considered onerous or unfair.

RIGHT TO USE MOTOR RIGHTS

Thus, a sizable number of railroads considered they had a right to use the motor rights thus acquired to engage in an all-motor freight business, along the lines of their rails, as well as in substitute service, and without restrictions requiring prior or subsequent rail haul, rail billing, or the imposition of so-called key points. Indeed, their willingness to pay for certain acquisitions was based on the belief that they would have the right to carry on a flexible motor service.

NEW RIGHTS BY CERTIFICATE

The third manner in which a railroad might provide co-ordinated motor service is to go before the ICC and obtain new rights by certificate—in its own name or that of its motor subsidiary. Almost from the beginning, the Commission restricted new authorities granted to operations limited strictly to rail-hauled freight. As set forth in its leading precedent decision, in the Kansas City Southern Transport Company case, decided in 1938, the Commission insured the auxiliary nature of the motor rights granted by imposing five conditions—including one that shipments handled must receive a prior or subsequent movement in a railroad car. In 1940, in a further consideration of the Kansas City Southern case, the entire Commission modified the restriction so that the rail haul was eliminated as a condition. But there was substituted therefor a so-called key point condition. This provision has since become the major target of the railroads' opposition to the ICC's regulation of railroad trucking. Hence, it needs to be explained.

In decisions containing key point provisions, the ICC itself establishes certain points on the applicant railroad between which or through which it cannot move freight on motor trucks. The theory is that, since the purpose of the authority is to allow the railroad to substitute trucks for local way freights, and nothing else, trucks should be used

only to fan out of break bulk stations, to and between which rail cars must be used. The actual intent and effect of the key point restriction is to prevent the railroads from providing an all-motor service, except on very short, local, or branch line hauls. The restriction thereby prevents them from competing with motor carriers on a time or service basis.

In almost every subsequent decision involving applications by railroads for new certificates, either the key point restriction, or the prior or subsequent rail haul restriction, or both have been included. Since both are onerous, railroads seeking to enter or expand their motor operations resorted largely to the expedient of buying existing carriers' rights, since authorities theretofore did not contain these specific restrictions.

ROCK ISLAND'S MOTOR SUBSIDIARY

Did not, that is, until 1946, when the Commission (with three commissioners dissenting) decided to go back and attach them where they had not been imposed in earlier acquisition cases. It modified authority granted to the Rock Island's motor subsidiary in 1938 and forced it to divest itself of all its all-motor operations. Similar mayhem was done to such of the Texas & Pacific's fine interstate motor operation as was not protected by ironclad rights. The two cases ultimately went together to the U. S. Supreme Court which, just last spring, decided in favor of the ICC, by a decision of five to four.

As it stands today, a railroad wishing to extend co-ordinated motor service must, for the most part, accept the key pointing and/or "prior or subsequent" rail haul restrictions, whether it goes out for new certificates or buys the rights of an existing motor carrier. In short, if a man buys a new suit to order, the tailor makes it without pockets or buttons. If he buys a second-hand suit, so that he can get pockets and buttons, the tailor makes him rip them off before he wears the suit. He does not get what he buys.

BARS SUBSIDIARY FROM CARRYING FREIGHT

Either of these restrictions automatically bars a railroad subsidiary from carrying freight at motor rates on motor bills, or from interchanging with motor carriers, even where those practices are not specifically prohibited. There are exceptions. Just two months ago, for example, a big railroad received unrestricted rights to operate an all-motor service. But the route involved served small towns only, not served by any other motor carrier, and public demand for the railroad-affiliated service could hardly be ignored. A number of railroad companies still operate subsidiaries enjoying flexible operations, the major part of whose traffic is all motor. In some instances, the ICC could, conceivably, re-examine its authority and impose the conditions cited. In others, absence of the "saving clause" probably prevents it from doing so.

I might say, parenthetically, that the absence of the "saving clause" may prevent it from doing so, but just this week the Commission added restrictions to five certificates held by the Frisco on the ground that the certificates had been inadvertently issued without those conditions attached to them. The Commission made quite a point of the inadvertence and then explained it, in fact, at such length that

it looks as though they were a little ashamed of it or were trying to build up a record against future court action.

I do not know, of course, whether it will be taken to court or what the outcome will be, but I have been wondering a little bit since I saw that. It seems to me that theory of inadvertence opens up a whole wonderful new world of bureaucratic confusion. (*Laughter*) I am wondering if I would be safe in inadvertently omitting a few items on my income tax return. (*Laughter*) I don't think I'll do it this year, anyway.

RAILROAD TRUCKING OPERATIONS HOGTIED

The legitimate "beef," in my opinion, is that a large portion of railroad trucking operations are hogtied by the authorities on which they are based. Even more important, if the policy of the Commission continues, future expansion of railroad trucking will be severely limited, both in extent and in the nature of the service it can render the public.

WHAT THEY WANT

The railroads are divided into two schools of thought as to whether they ought properly to go into the trucking of freight on motor bills at motor rates or to interchange with other motor carriers. Some railroad operators of large trucking subsidiaries advocate a hands-off policy. But, I believe I am correct in stating that all railroads with experience in motor trucking agree in opposing the restrictions of key pointing and "prior or subsequent rail haul."

BEST EXPOSITION OF RAILROAD'S POSITION

Perhaps the best exposition of the railroads' position is set forth in the statement of W. L. Grubbs, general counsel of the Louisville & Nashville, identified as number 6 of an admirable series of statements, submitted last year on behalf of the industry to the Senate subcommittee on domestic land and water transportation, which have won strong support for the railroads' position on regulation and subsidy generally in the "progress report," which was issued by that subcommittee last month. I commend their reading to you. Declared Mr. Grubbs:

There would seem to be no substantial reason why such restrictions should be imposed in acquisition cases, thereby destroying to a considerable extent the possibility of economical use, and accordingly the value, of the thing acquired, or in new application cases where it is not shown that the public is already adequately served with all-motor service by existing motor carriers.

The only reference in the whole of the Interstate Commerce Act to special treatment of railroads with regard to trucking rights is that in section 5(2) regarding their acquisition of a motor carrier, in which it is stated that the ICC "shall not enter such an order unless it finds that the transaction proposed will be consistent with the public interest and will enable such carrier to use service by motor vehicle to public advantage in its operations and will not unduly restrain competition."

It is on this slender reed that the Commission has erected its "policy" of restrictions that I have enumerated. Congress is supposed to make policies—not administrative agencies. It is clear that nothing in the law gives the ICC the right to erect special barriers against use of motor trucks by rail-

roads. The commission has been doing its own legislating.

That is why, in his statement to the Senate subcommittee, Mr. Grubbs declared, on behalf of the railroads:

We advocate that this proviso be so clarified as to preclude such an interpretation and enable it to be plainly understood that conditions should not be imposed which will operate to prevent economical and efficient use of motor vehicles in their service.

We believe this could be done by changing the following language of the proviso: "to use service by motor vehicle to public advantage in its operations" to read "to provide an improved general transportation service to the public."

We think this would make it clear that the Commission should not place a narrow interpretation on the will of Congress that motor vehicles may properly be employed by railroads where their use will enable the railroads to render an improved public service.

Of course, to win their point politically, the railroads have to show that the ICC's restrictions actually prejudice the public interest. They can.

COST OF OPERATION

Take first the question of cost of operation. Less-carload traffic generally flows in one direction—out of market centers. A reasonably balanced movement exists only through from one market center to another. In either case, a railroad truck under key point restrictions is doomed to empty movement, in one direction, because it cannot be used to carry freight through. Even in routes out of market places only, were a railroad permitted full motor rights, it could accept freight in interchange with other motor carriers in the direction of empty movement, for a through haul.

To get more efficient utilization of their trucks, a number of railroads use intrastate rights to haul all-motor freight, and run them, through, we will say, from point A to point F. If freight picked up at B is intrastate, it is run through by truck, in fast time. But, if it is interstate, under key pointing, it may go by truck only as far as C, where it must be put through the freight house and wait—perhaps a day or so—for movement in a boxcar (probably a lightly loaded one at that) for movement to D. Here it is again transferred to a truck for the final haul to E. I know of cases where interstate freight lands in the same truck on the second transfer that it left on the first one—except that the truck left two days later.

This kind of monkeying about raises handling costs sharply and uses up scarce boxcars for no good purpose.

It follows that key pointing also makes it impossible for the railroad to provide the shipper with the service that he wants or that is required to make it competitive with all-motor service. Thus, the effect of the ICC's policy is to throw an iron curtain of protection around the motor carrier industry by restraining the railroads from giving it effective competition.

There is an "angle" to this question, which may not have occurred to you. When the independent motor carriers started in business, they found their first customers where railroad service was worst—the handling of less-carload shipments from and to smaller points, for short hauls. They eagerly accepted the small shipments, which the railroad found hard to handle profitably. If at any time they needed protection, it was then.

Now that the highway-freighter has become "big busi-

ness," he has encountered the same economics as the railway. Unlike the railway, he has the right to pick and choose what he will carry. He does this with rate stops which drive the "balloon" or awkward freight to the railroads. Or he tells the manufacturer of screens or desert coolers that he has no equipment—and could he take his stuff to the railroad station? As for the smaller towns which gave him birth, he won't stop at them. In many instances he gets certificates that forbid him to. In contrast to the railroads, which serve every point through which their rails pass, haulers between Chicago and the Pacific Coast may serve only one or two intermediate cities. The average haul of shipments via Pacific Intermountain Express is 1,600 miles, compared with about 220 miles for all Class I railroads.

DEPENDENT ON LESS-CARLOAD SERVICE

The result is that the victim of this discrimination has become utterly dependent upon railroad less-carload service. The fact that this form of discrimination is likely to spread further explains to me why so many big shippers—who boast that they do not ship their merchandise by railroad any more—worry about railroad lcl service and scream about its improvement. They must be insuring a usable service for the future, to which they can return the stuff the trucks will not take!

Where railroads have operated co-ordinated motor service, the dependence on it has been even greater than on rail service, because the shipper gets motor speed and frequency, and, in some cases, motor rates and interchange with motor carriers. In certain sections, railroad-operated motor service came to represent "the old reliable"—the service that took care of everybody and neglected no towns along the route.

Some people doubt that shippers ever know or appreciate satisfactory service. Renoir, the French impressionist, was found one day painting a nude. His visitor asked him when he thought the painting would be considered satisfactory. The painter replied: "When I start to put my hand on her derriere." You can also tell when a shipper considers service satisfactory—by his screams when somebody tries to take it away.

INDEPENDENTS APPRECIATE IT

Even the independent motor carriers appreciate it. Take the truck route of one middle western railroad which ran on the same highway with a large number of big independents, possessing far-flung operating rights. The railroads' trucks served every station on the line, both for motor and rail-billed freight. They also interchanged freight with other motor carriers. The big independents found it expensive to stop at anything but the big cities en route. When they received shipments for the small places, they simply interchanged them at the nearest big city with the railroad truck line, which delivered them. The latter used to handle more than 150,000 interline shipments—most of them small and destined for smaller towns.

ASSEMBLED FIGURES

This same railroad truck line assembled figures which showed: (1) that unrestricted railroad-owned subsidiaries

do not drive the independents out of business, and (2) that railroad-operated trucks perform an essential service which the independents have abandoned. Thus, from 1946 to the end of 1949, although as yet the ICC restrictions did not apply, and despite every effort made to compete, motor-billed freight hauled by the railroad subsidiary increased but slightly; tonnage handled by 10 independents in the territory doubled; and railroad lcl freight (by truck or rail) declined by almost 50%. Point 2 is demonstrated by the fact that, in the period 1944 to 1949, the average haul of the 10 independents increased from 450 miles to 630; (meaning, they neglected the smaller points), the average haul on the railroad as a whole decreased from 350 miles to 305, and the average haul on the railroad subsidiary remained the same—160 miles. Similarly, the average truck load of the 10 independents rose from less than 8 tons in 1944 to 10½ tons in 1949, while that of the railroad subsidiary declined from 7¼ tons in 1944 to 4½ tons in 1949. These cold figures tell a story about discrimination.

NOT A COMMON CARRIER AT ALL

They show that the independent common carrier trucker is not a common carrier at all.

So it is not strange that, when a court affirmation of a restrictive action by the ICC gave a sentence of death recently to a popular all-motor service organized more than a decade ago by a railroad, the 500 employees who were to lose their jobs joined communities all along the line, individual shippers, the state utility commission, and even connecting independent motor carriers, in strenuously urging that the service be permitted to continue. The ICC revoked the death sentence temporarily and allowed the railroad to go on rendering an all-motor service for sixty days. It did, however, "protect" the independent motor carriers by imposing, for the first time, a limitation on the size of less-truckload shipment that could be handled—thereby insuring that the railroad can get only the undesirable lots. Just recently, the ICC extended temporary authority for 120 days additional and increased the maximum weight of shipment from 2,000 to 5,000 pounds.

All of which leads to my summary. It is clear that the public needs the true common carrier service offered by railroads. The railroads can continue to give it only if they can operate flexible co-ordinated motor service, in which they have opportunity to compensate with desirable freight for the profitless loads that they carry as a sheer public service. Restrictions make it impossible for them to move freight economically, or to get even within range of competing with the independent motor carriers in service.

Where the railroads have operated flexible motor service, they have not driven independents out of existence. On the contrary, the latter have flourished and have even used the railroad subsidiaries as a convenient ally. Although the American Trucking Association adheres to a policy of opposing all grants of authority of any sort whatever to railroad motor operations, some of its members have publicly supported the continuance and expansion of railroad motor subsidiaries.

The railroads do not seek any better treatment than any

other applicant for new motor rights or the right to acquire existing ones. But they do not want, or deserve, any worse treatment. And nothing in the law says they ought to or must get it.

NOT ANXIOUS TO SCRAP EXPERIENCE AND ASSETS

The ICC may rest assured that companies whose officers have grown up as railroaders and who have sunk irrevocably most of their capital in roadway, bridges, and tracks are not anxious to scrap their experience and their assets and take to the public highways. Use of trucks for lcl by the railroads is a simple adjustment to the fact that the mass-mover freight train is neither economical nor serviceable for small-lot shipments where volume is low. The railroads' aim is to co-ordinate road and rail in the best proportions. Their officers may, I think, be trusted to put everything on rails for as long a portion of the haul as is feasible—providing service is as good as or better than all-truck.

Most of the motor subsidiaries of railroads, which still have the right to accept freight on motor bills at motor rates, nevertheless transfer that freight into rail cars (the subsidiary dealing with the railroad as does a forwarder) for those portions of the haul where rail movement is fastest and cheapest. Several of them place their trailers on railroad flat cars for the long haul. This is the kind of co-ordination for the country as a whole to aim at.

In 1948, the *Railway Gazette*, British contemporary of my paper, carried a piece by a correspondent which described the ideal form of transport co-ordination as being "the kind of transport system which would have emerged if the steam locomotive and the road motor vehicle had been invented at the same time." In short, there should be nothing sacrosanct about either.

ONCE A PROPONENT OF CO-ORDINATION

The ICC itself was once an enthusiastic proponent of real co-ordination. Two investigations on its own motion, which involved hearings all over the United States, produced lengthy reports, in 1928 and 1932, respectively, which found that excessive competition between motor carriers and railroads is detrimental to the carriers and to the public interest, and which urged the railroads to substitute motor service for rail whenever economics could be effected thereby or service improved. And the most active and realistic member of the Commission until his death in 1943, Joseph B. Eastman, continually admonished the railroads to go into the motor trucking business, especially during his term of office as Federal Co-ordinator of Transport in the depression. Perhaps, like the man who found strength in feeling the sword carried by his ancestor, the Commission may today find wisdom in its own past. (*Applause*)

* * *

Chairman Bretey: Thank you for that very fine paper. Our next speaker has been associated with a railroad which is obtaining a marked degree of success in regaining some traffic volume previously lost to trucks. His railroad, the Chicago & Eastern Illinois, stands as one of the pioneers in offering intelligent competition to the truckers. Our

speaker has been connected with the Chicago & Eastern Illinois in its traffic department and is in a position to answer questions most authoritatively. It gives me great pleasure to introduce to you George N. Sabin, assistant general freight agent of the Chicago & Eastern Illinois Railroad, who will speak to us on the subject: "The Movement of Highway Trailers on Flat Cars." Mr. Sabin! (*Applause*)

* * *

George N. Sabin: It is interesting to note that there still exists a feeling among railroad men, in both operating and traffic departments, that the movement of highway trailers on railroad flat cars is a new and novel experiment, something to be fully discussed and not heedlessly rushed into. Entirely forgotten or overlooked is the fact that experience with this type of service dates to 1926, when the Chicago North Shore & Milwaukee pioneered in this field by offering a less-carload service, moving for its own convenience, by the utilization of railroad-owned semitrailers loaded on flat cars. In the true sense of the word, the modern conception of the operation was formulated in 1932 by the North Shore when it offered the flat car service to over-the-road motor carriers. The two truly successful railroads in this field are the Chicago Great Western which initiated the service on its line in July of 1936 and the New York, New Haven & Hartford which entered the field in December of 1937. Two railroads successful in this field for approximately fourteen or fifteen years and located in different areas of the country—the Great Western in the Middle West and the New Haven in the East—indicate the feasibility and the profitability of this type of movement.

ODD BEDFELLOWS

An article in the March 20, 1951, edition of the *Wall Street Journal* headlined that: "Odd Bedfellows—Railroads and Truckers Are Doing Business with Each Other" and mentioned the interest of the Chicago & Eastern Illinois Railroad in this operation. It apparently created what we might justly call a "sensation" in the industry, and officials of 25 separate railroads evinced their interest in the matter by writing, phoning, or paying personal visits to the C&EI offices.

The *Chicago Tribune* in its September 9, 1949, edition stated the problem rather well:

It is no easy problem which railway managements face these days as they scan means of meeting motor truck competition. The rate increases they have obtained to meet advancing operating costs have made it all the easier for trucks to undercut rail rates. While railroad carloadings are going downward, truck loadings are on the upgrade.

A report by the Interstate Commerce Commission published in the October 20, 1951, edition of the *Traffic World* substantiates the *Tribune* statement:

In 1950 the railroads accounted for 58.7 per cent of the total intercity ton-miles of freight, as compared with 60.6 per cent in 1949. The largest rail share of total ton-miles in the 1939 to 1950 period was 72.8 per cent in the war year 1943. Since that year the railroads' share of the total traffic has declined successively each year and fell below 60 per cent for the first time in

1950. Highway truck traffic which showed relative declines during the war years, accounted for only 4.5 per cent of the total intercity ton-miles in 1944. Subsequently the truck percentage has risen uninterruptedly to a peak of 12.4 in 1950.

Furthermore, although all modes of transportation showed increased traffic for 1950 compared with that of 1949, the report discloses that:

Highway truck traffic showed the greatest relative increase, 34.5 per cent, and railroads the smallest, 11.6 per cent.

The aforementioned *Tribune* article went on to say:

One method of meeting this problem has been adopted by the Chicago Great Western, the New York, New Haven and Hartford, and Denver and Rio Grande Western Railways. It comes under the "if you can't lick them, join 'em" philosophy. These roads have rates for carrying loaded truck trailers on flat cars between specified points.

Basically the system employed is predicated on serial end loading of conventional-type highway semitrailer bodies on flat cars. This type of loading has been utilized because of the low initial cost of providing necessary terminal facilities and the low cost of fitting out the flat cars. The flat cars are equipped with fasteners and special devices necessary for this movement. Fundamentally, these patented devices—royalties for which are still payable to the North Shore—consist of heavy bolting timbers along each side of the car to act as guard rails, chuck blocks to fit in front of and behind the rear wheels of the highway vehicle, screw top jacks to support the front end of the trailers, and chains with turnbuckles extending from the floor of the car to strategic points on the trailers to hold the highway vehicles firmly in place on the flat car.

TRAILER-LOADING OPERATION SIMPLE

Physically, the trailer-loading operation is simple. A loaded trailer is backed up a ramp by a tractor onto the first of a string of flat cars that have steel plates bridging the gaps. The trailer is backed until it rests on the last of the flat cars in the string, and the tractor is then uncoupled and the trailer properly fastened. The other trailers are then progressively loaded in a like manner. Then, trailers fastened, steel plates raised, the string of flat cars is picked up by the usual switching crews and forwarded in the customary freight trains to destination. The unloading operation is naturally the same as the loading operation but in reverse.

THE PLAN UNTIL 1946

Until 1946 the plan contemplated the loading of two trailers up to 26 feet in length on flat cars that were usually 53 feet or so in length. Since 1946 the physical size of the trailers offered for this movement has varied from 26 to 35 feet, creating a problem of attendant loss in revenues, resulting from the loading of only one trailer to a flat car. Consequently, the New Haven, for one, has set in motion plans to construct or have constructed 40-foot flat cars which, however, seem to have other advantages—on loss of time in loading or attempting to assemble two trailers suitable in length for any one flat car, and full utilization of the car if converted for regular service. The New Haven does report that, as a matter of information, it has found

that the scheme of loading one trailer per flat car speeds up the average loading time and eliminates time losses resulting from matching or pairing of bodies.

EQUIPPING THE FLAT-CARS

Equipping the flat cars for this service approximates a cost between \$900 and \$1,400; the cost for the ramps range from \$6,000 to \$8,000. Other terminal facilities are usually constructed, such as lights, catwalks, or working platforms, by the New Haven, but these are further refinements that are not basically necessary. It is ordinarily necessary to have properly equipped flat cars and suitable ramps for end-on loadings and to have the motor carriers equip their trailers with brackets to hold the chains with which the trailer is moored to the flat car. Estimated costs for these brackets by New Haven officials range from \$25 to \$30 for a trailer having full frame construction and \$75 to \$100 for a trailer having "frameless" construction.

CHARGES ARE REASONABLE

Charges for this service are reasonable and are made attractive to the motor carrier, inasmuch as the charges that are customarily stated on a per-trailer basis are computed on the motor carrier's over-the-road costs obtained from ICC sources. No attempt is made to classify the contents of the trailers, but the motor carrier certifies to the fact that no contraband is located therein. Commodities usually excluded are, for example, livestock, jewelry, valuables, coal, and coke. Empty returned trailers are charged just one-half the amount charged for loaded trailers.

LOW COST OF OPERATION

The fact that this traffic moves in the regularly scheduled through freight trains, requires no absorption of foreign line switching, is usually a two-way loaded movement, and has little or no claim payments indicates the probably low cost of operation and the resultant profitability.

THE NORTH SHORE

The operation as installed by the North Shore in 1932 reached a peak of over 40 trailers a night. The service was operated between Chicago and Racine and between Chicago and Milwaukee until 1939 or 1940. Many factors finally made this particular operation a liability, such as the shortness of the haul, only 85 miles; the fact that the terminal in Chicago was located on the north side and the terminal in Milwaukee on the south side, thus reducing the haul somewhat; the handicap of inaccessibility at both terminals, many times influencing the motor carrier to haul the freight himself; the unreliability of the individual motor carriers; and the selfish and irregular use of the service by the motor carriers.

THE ALTON RAILROAD

The Alton Railroad, now the Gulf, Mobile & Ohio, established the service between Chicago and East St. Louis in October 1932 as a strictly intrastate operation. Shortly thereafter it was discontinued, basically because of operative difficulties, such as constant requests that the outbound Chicago trains be held up for late trucks, despite mutually agreed-on changes in freight schedules, but also because it

was used solely when it was of benefit to the motor carriers—for example, when roads were impassable from snowstorms—and because several bankruptcies during the depression affected the proper collection of charges.

ROCK ISLAND INTRASTATE SERVICE

During the early '30's, the Rock Island offered a similar intrastate service between Chicago and Peoria and between Chicago and East Moline—the former a distance of about 160 miles, the latter 180 miles. The service was offered for a short while and discontinued about fifteen years ago. The Rock Island made no attempt to obtain special equipment or build elaborate ramps; the only equipment utilized was eyelets on flat cars to which the trailers were fastened—the ramps were constructed of old railroad ties packed down on sand, dirt, or gravel. The discontinuance apparently was caused by the principal participating motor carrier's hauling most of the freight over the road during the slack depression period and the constant opposition of competing rail carriers to what they considered a detriment to their revenues and a potential threat to the established level of rates.

CHICAGO SOUTH SHORE & SOUTH BEND

The Chicago South Shore & South Bend experimented as far back as 1936 with a system embodying the principle of a trap car service (or less-carload traffic) in trailers. Owing to the short haul and the resultant unprofitableness of the venture, however, the operation was canceled many years ago.

UNITED FRENCH RAILWAYS

It is noteworthy that the United French Railways instituted the trailer on flat car system during 1936 and 1937 and at present apparently have the system operative at 57 stations in France—5 of which are located in Paris. Twenty additional stations are being equipped.

It is unlike the system employed in the United States in that a smaller rail car, smaller trailers, and an entirely dissimilar method of loading and fastening are in use.

The equipment is offered by an independent organization, on a mileage basis to the French railroad system, and on a use charge to the shipper.

RATIONAL METHOD OF TRANSPORTATION

The UFR system is a rational method of transportation of freight from door to door without rehandling, using rails for the line haul portion and the roads only at both ends of the rail.

The UFR system uses highway tractors of a standard type, but uses highway semitrailers specially equipped for the transportation by rail, cars specially equipped for transportation of trailers, and equipment at the stations allowing quick loading and unloading of the trailers on and from the cars.

The patents of the UFR system aim to make the passage from road to rail and vice versa as quick and as simple as possible, so that not only does this system eliminate all rehandling, but it also avoids any loss of time during transportation. This condition is essential in order to obtain efficiency and provide a low cost of transportation. The

UFR system of transportation has demonstrated that the system combines the advantages of the rail and the road and that the transportation is faster, more regular, safer, and more economical. An attempt has been made to introduce the French system into the United States last year by the independent organization that is now handling the operation in France.

DENVER, RIO GRANDE & WESTERN

During 1936 the Denver, Rio Grande & Western started to operate and still continues to operate a trailer on flat car service, limited to groceries and related items, between Denver and Grand Junction, Colo.

CHICAGO, BURLINGTON & QUINCY

The Chicago, Burlington & Quincy has a trailer-on-flat-car movement in operation between Chicago and Galesburg in connection with its own subsidiary, the Burlington Transportation Line, on a contract basis. Before the establishment of this movement, the CB&Q considered the question of making the operation available to all common motor carriers but had discarded the idea, mainly because it believed that the establishment of this type of service might prove to be harmful in its dealings with carloading companies. In fact, in 1944 the CB&Q and other western lines refused to install the service between Chicago, Denver, and Los Angeles for the Ringsby Truck Lines. The refusal was made the basis of a formal complaint to the Interstate Commerce Commission and reported in volume 263, page 139, under *Ringsby Truck Lines, Inc. v. AT&SF Ry. et al.* The Commission therein upheld the rail carriers' contention that:

... they have no duty to provide the service desired in emergencies at special rates and that the tariffs they now have on file provide lawful rates on all of the commodities shipped by the complainant, including the semi trailers.

In the very same case, the Commission held that the practice of common carriers by motor vehicles acting as common carriers by motor vehicle and as shippers by rail for the same service was repugnant to the act.

CHICAGO GREAT WESTERN

In order to do justice to any discussion of the operation on the Chicago Great Western, I am taking the liberty of quoting copiously from the "Compendium" issued by the Great Western through the freight traffic manager. The foreword thereto, which is pertinent to any discussion of the operation, states in part that:

Prior to July 7, 1936, which was the effective date of the first Great Western's Trailer on Flat Car Tariff between Chicago, Illinois and St. Paul, Minnesota, the Great Western's efforts to regain the substantial amount of merchandise tonnage it had lost to the motor carriers were not productive of good results. Trailer on flat car service proved itself to be a source of attractive revenue to the railroad and an economical operation for the motor carriers. The method of publishing rates and charges, first by an individual tariff of the railroad's, then by joint motor-rail-motor rates, and finally by the so-called Substituted Freight Service Directory, is an interesting phase of tariff publication.

The form of publication, known as a Substituted Freight Service Directory, and filed with the Interstate Commerce

Commission, in substance, provides that, if the shipper does not object, the motor carrier may transfer the trailer to the rails—the tariff specifically describing the territory to be traversed. No rates or charges are shown in this publication. The entire movement is charged on the basis of a published through motor carrier rate.

In Chapter VI of the Compendium it is noted that

... since the inauguration of trailer-on-flat-car service between Chicago, Illinois and St. Paul, Minnesota, effective July 7, 1936, the Great Western has voluntarily expanded this type of service to include movements between Chicago, Illinois on the one hand and Council Bluffs, Des Moines, Iowa, and Kansas City, Missouri on the other hand, also between Des Moines, Iowa and Kansas City, Missouri, and between St. Paul, Minnesota on the one hand and Des Moines, Iowa, Kansas City, Missouri, and Council Bluffs, Iowa on the other hand. The Chicago-Council Bluffs service was effective April 15, 1948; the Chicago-Kansas City service was effective October 25, 1948; the Chicago-Des Moines service was effective September 2, 1949; the Des Moines-Kansas City service was effective September 20, 1950, and the service between St. Paul on the one hand and Des Moines, Kansas City, and Council Bluffs on the other hand was effective February 23, 1951.

At the time the service between Chicago and St. Paul was inaugurated, there were only 17 common motor carriers using the service. As of April 1951, there are 43 such carriers using this service.

CHICAGO TO ST. PAUL

I thought it might be interesting to select Chicago to St. Paul, entailing a distance of 425 miles, as illustrative of the charges made by the Great Western, as shown in a division sheet, published by the Great Western and listing all the participating motor carriers. It is noteworthy that this form of publication is not filed with the ICC nor available to the general public. Therefore, it enables the Great Western to easily amend, change, or cancel any of the items, and, furthermore, any desired change can be made immediately or can even be made retroactively, if this is necessary.

The charge for the movement between Chicago and St. Paul of a trailer not exceeding 28 feet in length (outside measurements) with a load not exceeding 20,000 pounds is \$54.60. If the load exceeds 20,000 pounds, the charge for the movement of this trailer is \$67.75. For an empty trailer within the length specified above, the charge is only \$27.30. These afore-mentioned charges are all based on the fact that two trailers within this limited size can physically be loaded on one flat car. For trailers exceeding 28 feet in length (outside measurement) the charges are \$81.90 on loads not exceeding 30,000 pounds, \$95 on loads exceeding 30,000 pounds, and \$32.50 for an empty trailer. The latter provisions are calculated to provide enough revenue on a one-trailer per car basis. Therefore, a further application is provided for the shipper who offers only one trailer not exceeding 28 feet in length (outside measurements). A charge of \$81.90 is made for a single trailer with a restrictive application that limits the gross weight of the trailer to 60,000 pounds, and a charge of \$32.50 is made for an empty single trailer of the specification noted.

The benefits derived from this form of operation (which limits the operation to motor carriers only, whereas that of

the New Haven is open to motor carriers and private shippers) are:

1. The rail carriers enjoy a division of the revenues accruing from business that is exclusively motor carriers.
2. This system does not disturb any rail scale of rates.
3. Practically all damage and loss claims are eliminated, except those possibly caused by rail wrecks.
4. The only form of solicitation necessary is the approach to motor carriers or motor carrier bureaus.
5. It is a good source of additional revenue, if the fact is kept in mind that it is a divisional basis setup and not a local rate basis.

THE NEW HAVEN

The New Haven inaugurated this form of operation on December 15, 1937, but unlike the Great Western made it available to all. It operates today what it considers a highly successful service between Boston and New York, Providence and New York, Boston and New Haven, and New Haven and New York, and also between Springfield and New York. This service handled 1,506 trailers during the first full year of operation (1938). Since that time, the business has grown considerably, and, by comparison, in 1949, 17,679 trailers were carried, and, for the year 1950, 22,619 trailers were transported.

The New Haven believes that the operation is a profitable one because:

1. The traffic moves in volume among four concentration points—New York and New Haven in the west and Boston and Providence in the east.
2. The flat cars are switched into and out of the trains at a given time.
3. There is no excessive handling involved.
4. The cars receive maximum utilization and are in constant revenue service, each flat car making a return trip within 48 hours.

To make this service available to the public, the New Haven published a tariff, duly filed with the Interstate Commerce Commission and containing rates and charges that are somewhat on a higher level than those available to the motor carriers.

Current charges for transporting loaded semitrailers are divided into two sections, based on the length of the semitrailer, the first group covering trailers up to 26 feet in over-all length and the second group covering trailers from 26 feet to 34 feet in over-all length. Charges for transporting empty trailers are one-half the charges for loaded trailers.

CHARGES MADE BY NEW HAVEN

The charges made by the New Haven for trailers shipped between Boston and New York, a distance of approximately 207 rail-miles, serve to illustrate the basic scale of charges. But one must keep in mind the fact that these charges are made to private shippers and are, as I have stated previously, higher than those made to motor carriers, through the medium of a divisional agreement and not by published tariff.

For each short trailer offered for transportation, the charge is \$58.24 if the trailer and its lading do not ex-

ceed 32,500 pounds and \$29.12 if the trailer is empty. The charge for the longer trailer is \$61.88 if the trailer and its lading do not exceed 35,000 pounds, and \$30.94 if the trailer is empty. A special application in the tariff provides that 26 cents per 100 pounds shall be added to the stated charge for any excess weight except that, in no case, shall the charge for a short trailer exceed that published for a long trailer.

In a move designed to stimulate business and recover traffic moving on the highways, the C&EI constructed the necessary ramps in 1948 at its three major terminals: Chicago, St. Louis, and Evansville. This service was not too productive at the time, but it indicated that it was a move in the right direction. The C&EI still feels that this highway traffic is business we do not now have, and efforts are still being made to move it back to the rail. However, any revenue we are able to obtain from the motor carriers represents new and additional revenue. With this thought in mind, the C&EI reinstated a trailer flat car service between Chicago and St. Louis in 1951 by contract with a motor carrier and hopes to expand this service finally to include private shippers, similar to the New Haven method of operation.

Current negotiations between the C&EI (through its agent, the Rail-Trailer Company) and a motor carrier conference group may be culminated shortly and lead to an extensive service between Chicago and St. Louis.

The C&EI tentatively proposes to charge, for the movement between Chicago and St. Louis, approximately 275 miles, \$35 for a short trailer, weight of lading not to exceed 33,000 pounds, and \$55 if lading exceeds 33,000 but not 50,000 pounds. For the longer trailer, the charges would be \$45 and \$65, respectively. For an empty short trailer the charge would be \$20; and a \$25 charge would be made for the empty longer trailer.

There are many visible advantages to the railroads—among them are:

1. Additional compensatory carload traffic will be acquired.
2. Lcl revenue, lost to competitive forms of transportation, will be returned to the railroads, in profitable carload movement.
3. Nonrevenue empty car movement will be totally eliminated.
4. There will be a complete revenue movement every day.
5. Daily rail car revenue will be several times greater than average rail car revenue.
6. Loss and damage claims will be reduced.
7. Rail disabilities in traffic, lost by the railroads as a result of many advantages offered by truck service, will be overcome.
8. Flat cars employed in this service can readily be returned to regular service.
9. Switching costs and time will be reduced.

The obvious advantages to a common carrier by motor vehicle are many and varied:

1. Cost of moving his over-the-road traffic by rail will be fixed and static.

2. Interstate weight and license barriers, in most cases, will be absent.

To quote a recent editorial in the *Railway Age* of October 15, 1951:

The truckers faced with increased weight restrictions, and more intensive policing of public highways—not to mention the spectre of a pending Illinois ton-mile tax (as is the case in the State of New York)—are evincing considerable interest in the use of flat cars for transporting their loaded trailers.

3. The constant use of the system will reduce equipment investment and depreciation, particularly in the number and type of tractors (less expensive city-type tractors can be utilized).

4. Insurance costs will be reduced.

5. There will be a reduction in personnel and thereby a reduction in personnel problems.

6. Garage and maintenance requirements will be reduced.

7. The very expensive dead-heading to balance equipment will be eliminated.

8. It will help tremendously in extending the life of tires on trailers by the elimination of road hazards and hard wear.

9. Constant increases in expenses due to new laws affecting licenses and gasoline taxes will be avoided.

10. Loss and damage claims which were caused by road hazards will be reduced.

11. Delays caused by unfavorable highway conditions, such as snowstorms and washouts, will be avoided.

RATES A SERIOUS HURDLE

Rates represent one of the serious hurdles that must be overcome. The movement of highway trailers will require a low all-commodity rate, and that may conflict with existing all-commodity rates being used for the movement of forwarder traffic.

ANOTHER TRAFFIC PROBLEM

Another traffic problem is the danger of one railroad invading another's territory. For example, if one railroad were to move trailers on flat cars from Washington to Atlanta, it might develop that some of the trailers actually originated in New York and were destined for Jacksonville. The roads operating from New York to Washington and from Atlanta to Jacksonville might not like the idea—even though they could offer connecting flat car services.

Many of you probably recall the advertisements placed in national magazines by the trucking industry national defense committee which screamed that:

Railroads are the Primary Target!

The "ad" went on to point out that:

As anyone who reads the daily newspapers knows, railroads have been the primary target in the Korean War. American railroads, by their own admission, would also constitute a primary target, should we be bombed. Why, then, do we close our eyes to these important facts.

Whether or not we care to give any consideration to this blatant outpouring is incidental. However, on due

consideration, we do have to concede that the concentration of freight terminals makes a tempting target for any adversary. If we admit that sabotage or any enemy action could readily disrupt a section of our national railroad system, the trailer on flat car system could become an interesting solution to these hazards.

In the event of damage to our rail terminals, rail service would be restored without substantial delay in many instances. This restoration of service could be accomplished through the use of bulldozers, which could hastily throw up earthen ramps just beyond the point of damage to the tracks. Or, in some instances, portable ramps could be utilized. Trailers on flat cars could then be loaded or unloaded by tractors, which would then haul them over the highways.

Thus, even if an entire city terminal system were destroyed, rail service could be restored promptly. Every flat car would contain one or two trailers (depending on length of flat car and of trailers), which could be removed at will and placed on the streets in order to be at points where and when needed.

Modern requirements demand a method with flexibility and the time-saving features inherent in this mode of operation, whether we are at peace or war.

As succinctly stated in an editorial in the July 2, 1951, edition of the *Railway Age*:

Today, probably more than ever before, individual railroads are giving serious study to the movement of highway truck-trailers on flat cars.

And the concluding paragraph emphasizes that:

The potentialities for profitable operation are such, however, that no railroad possessing routes which lend themselves to application of the idea should care to neglect exhaustive study of the situation.

(Applause)

* * *

Chairman Brèvey: Thank you, Mr. Sabin.

We have a little time for questions now. A lot of very interesting controversial questions have been raised here. Joe Small, this is down your alley. What question have you to ask? This is just what you have been saying for years.

Joseph Small: I would like to ask what the labor situation is on these trucks, what the unions have to say about it.

Mr. Sabin: There are situations that I know have arisen since, and one was on the New Haven. They have solved the problem in a sort of fashion. At least, the New Haven tells me that, under the interstate laws, they could not be stopped from operating, but, of course, the motor carrier would suffer as a consequence. So they now seem to have solved the problem in this fashion: None of their customer motor carriers will give them more than what they would consider a surplus. In other words, they would have to employ their basic number of chauffeurs, and that seems to be the way the New Haven solved their problem.

I believe several years ago I read about a water carrier that wanted to operate between Albany and New York, and labor stopped him completely. Those are about the only two cases I have heard about.

Question: Can you say that the New Haven is actually making money, and, if so, how much did they pull in, and how much net did they get?

Mr. Sabin: They keep it entirely separate.

Question: Don't they give you some idea?

Mr. Sabin: They considered it profitable. I do not carry the full figures with me. They do keep it separate, and I believe the brother of the president specializes in it and watches it very carefully.

Question: Did they make some net profit last year?

Mr. Sabin: They figure that this is very profitable.

Question: Why do not the other railroads go into it if it is so profitable?

Mr. Sabin: In most cases, it is again like the screaming headlines: "Odd Bedfellows." Many of them will not even talk to a motor carrier. The Southern Pacific was discussing the idea and yet in their discussions said that they definitely would not deal with a motor carrier—only with their own subsidiaries along the West Coast.

But, as I have said, there were at least twenty-five separate railroads that called me and wanted to know more about it, and in many cases three different executives of the same railroad called me up, apparently different divisions of the road,

Question: Is there any danger, after a heavy investment in equipment by the railroad, of the truck fleet threatening to go back on to the highways and causing repercussions?

Mr. Sabin: That danger always exists, but it is not so heavy an investment as most people consider. You can construct a ramp at two of your major terminals for about fifteen or twenty thousand dollars, and your flat cars do have to be equipped. Of course, you do not lose the flat cars, because they can be returned to service very easily. In fact, in our own company we did it in 1949. We removed the fasteners and equipment. There is some danger of it, and we know that some of the motor carriers have been selfish about it in the past. In other words, they approach you in the winter and drop you in the summer.

Question: You are trying to get traffic back on the rails and off the roads and you have 40 million allies that are licensed operators of motor vehicles. Why not do more to enlist those fellows on your side to get these causes of congestion off the roads?

Mr. Sabin: Approaching whom?

Question: Why not, for instance, send a letter to every operator of a motor vehicle who has a driver's license, showing him that there are empty rails waiting to carry the stuff that is in the trucks congesting the highways and, as I say, ruining his life every time he wants to take his car out?

Mr. Sabin: You happen to be right about that. We did not attempt to do that, but somebody has suggested even approaching the Governor of Illinois, in our case, and trying to get some benefits from him, because we are going to help or assist in taking some of these trucks off the road.

Question: You might be helping the truck company in reducing expenses in the long run, which will fortify him against the railroads, thereby weakening the railroads over the long term and strengthening the trucks. Isn't that a possibility?

On the other hand, taking up the previous speaker's thought, if the trucks continue to clutter up the highways, and we have 40 million people getting antagonistic to them, we might eventually have laws and a decent ICC regulation of trucks which will help the railroads. What are your remarks on that?

Mr. Sabin: I believe all your statements are true except that the railroads have reached a point now of concluding that the motor carriers are here to stay. In my own railroad we are on a highly competitive route. We run main lines from Chicago to St. Louis, a beautiful overnight haul for the motor carrier, and it is the same thing on our eastern line. So we are losing the revenue continually. Some of the traffic that we are losing we cannot get back.

As I tried to point out before, where I can get it back by rates I will still try to do it. We still believe we would like to share some of the traffic the motor carrier is taking and continually getting more of.

Question: Have you experienced any difficulty with gypsy operations in setting up your program? For instance, between New York and Boston a carrier who is short of equipment can hire a gypsy for around \$50 or \$60 for the round trip, and he can put on about \$350 worth of revenue. He has no equipment problem; he has his own insurance which covers it. There is little incentive for the truck operator to ship a loaded trailer over the New Haven as long as he can get these gypsy operators who own their own equipment and who, in some cases, because they are in business for themselves and enjoy being in business for themselves, are content to work for less than real union wages. Do you run into that problem out in the Midwest also?

Mr. Sabin: We have the same thing all over the country. In fact, the Commission, I guess, has passed the actual regulation, requiring that a thirty-day contract be made, to stop this individual sort of thing where a man is looking for an empty return load and walks in and practically takes it for little or nothing.

Question: I have another question I wanted to ask, which is somewhat off the subject of putting trailers on flat cars. Early this afternoon there was a talk on servomechanisms. I follow the railroads pretty closely and I am somewhat appalled by the number of people in your rate department—your rate clerks, your traffic analysts, your classifications and territories, and your commodity rates, and so on. It seems to me that you ought to be able to get the IBM people to design a machine for you to punch in a couple of figures, and out come the rates accurately. How many bureaus do you belong to, by the way?

Mr. Sabin: We probably belong to at least four.

Question: How much does it cost you a year?

Mr. Sabin: It runs into a lot of money. The memberships are pretty high.

Question: How many people in your rate department?

Mr. Sabin: In my immediate general office . . .

Question: I mean in the whole system.

Mr. Sabin: Most railroads would have quite a number, but actually I do not think we have more than a dozen or so. We are a small road.

I know this is not a fair way to answer your question,

but have you ever checked a rate? You know, we had the IBM people in. It takes something between a half-hour or a full day to check a rate.

Question: That is the point I am bringing up. It seems so complicated, whether it is nested or not nested.

Mr. Sabin: That is the easiest part of the problem. Once we have determined all that is the beginning of the problem. We start with the basic rate. A basic rate today, as we understand it, means a rate that was in effect just before July 1, 1946. That means that the rate we use is the one that existed before any of these subsequent increases went into effect. We determine the basic rate after we have determined the classification, which may be a problem in itself. But we have to determine our territory and our traffic. By that time we can only determine what we call the basic rate. From that we have to add four increases today and determine what particular increase applies to the commodity we are considering and what territory the shipment moved from and where it went. All that has to be determined before we put on 162 increases, and then we do the same thing for 166 and repeat it again for 168, and as of today we have 175.

So we need a lot of rate people. We had the IBM people in because most of our office is run by machinery now, and they discussed it with us. I think it was five or six months ago. They went away hoping to do something for us in the rates, but so far nobody has come back. *(Laughter)*

Major Hudson: I am not looking for trouble, but I think it is unfair to let Mr. Sabin bear the brunt of this. I think it might be pertinent to point out that there are at least two things under way now which may lead to a simplification of rates. One of them is the uniform class rates which have been ordered by the ICC, which should go into effect very shortly.

Mr. Sabin: I do not think either of them is going to help very much in computing the time needed to find a rate.

Major Hudson: The second one is probably much more important than the first. That is the tariff study group which the railroads have just set up in Washington with a view to simplifying the whole body of freight tariffs. Obviously, that is not an overnight proposition. It is a tremendously difficult job. It will take a long time, and I do not believe anybody knows now what results will be produced, but they certainly are aiming at simplification.

Question: I was told that there are five hundred million different rates.

Major Hudson: I would not disagree with you on that number.

Some years ago I was down in the L&N station in Williamsburg, Ky., and I wanted to talk to Louisville. So I went up to the agent's office and cut in on the company line, on which you can hear conversations all up and down the line. While I was waiting for a chance to break in, the agent at Jellico, Tenn., called the traffic office of Knoxville and said: "There is a shipper here who wants to know the carload rate on canned salmon from somewhere up around Seattle by water to San Francisco and rail to Jellico." The Knoxville man thought a moment and then said in a very soft southern voice: "Hell's bells, man, you know I ain't got that." *(Laughter)*

If a man has a certain commodity now—again, he still has to determine his territory and commodity—but, once he determines that, we give him only one table to show him his actual increase. He still has to find his basic rate.

Chairman Bretey: We have time for one more question. Do you have any? Well, thank you very much. We are all indebted to these two gentlemen for coming here and we thank you very much. *(Applause)*

SAFeway STORES

INCORPORATED



Preferred and Common Stock Dividends

The Board of Directors of Safeway Stores, Incorporated, on November 15, 1951, declared quarterly dividends on the Company's \$5.00 par value Common Stock and 4% Preferred Stock.

The dividend on the Common Stock is at the rate of 60¢ per share, and is payable December 14, 1951 to stockholders of record at the close of business December 3, 1951.

The dividend on the 4% Preferred Stock is at the rate of \$1.00 per share and is payable January 1, 1952 to stockholders of record at the close of business December 3, 1951.

MILTON L. SELBY, Secretary.

November 15, 1951.

Avisco

AMERICAN VISCOSE CORPORATION

Dividend Notice

Directors of the American Viscose Corporation at their regular meeting on December 5, 1951, declared a year-end dividend of fifty cents (50¢) per share on the common stock, payable on December 28, 1951, to shareholders of record at the close of business on December 17, 1951.

WILLIAM H. BROWN
Secretary

GOOD YEAR

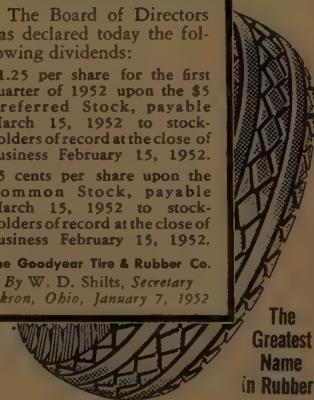
DIVIDEND NOTICE

The Board of Directors has declared today the following dividends:

\$1.25 per share for the first quarter of 1952 upon the \$5 Preferred Stock, payable March 15, 1952 to stockholders of record at the close of business February 15, 1952.

75 cents per share upon the Common Stock, payable March 15, 1952 to stockholders of record at the close of business February 15, 1952.

The Goodyear Tire & Rubber Co.
By W. D. Shilts, Secretary
Akron, Ohio, January 7, 1952



Minnesota Mining & Manufacturing Company's annual report this year will illustrate many of the products it makes, in addition to a review of current and past sales and earnings.

If you would like a copy of this comprehensive report, sign your name or pin your card to this announcement and mail to:

ARTHUR E. EGGERT

Vice President, Public Relations,
Minnesota Mining & Manufacturing Company

900 Fauquier
St. Paul 6, Minnesota

and a copy of this report will be sent you when it is published in March 1952.

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. . . The companies listed below are rendering a service to American industry by means of practical financial public relations. Their objective is better understanding between management and investors . . . security houses . . . the financial press.

As financial public relations counsel for these forward-looking companies, we can supply you with up-to-date information about their activities, progress, and prospects.

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Allen Industries, Inc.
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Consolidated Grocers Corp.
Dresser Industries, Inc.
Drewrys Limited U.S.A., Inc.
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Newport Steel Corporation
Pfeiffer Brewing Company
Robertshaw-Fulton Controls Co.
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Mack H. Fairburn, pipe fitter photographed by Fritz Henle at the Cities Service Lake Charles refinery, says a mechanic's best friend is his monkey wrench.

The Care and Feeding of Monkey Wrenches

THE MONKEY WRENCH is a creature with a long tail and adjustable jaws.

It is called a monkey wrench because an early-day nut-tightener with a vivid imagination thought it looked like a monkey. Given the proper treatment, fed a few drops of oil at reasonable intervals, it performs capably such services as building and repairing machinery by adjusting essential nuts and bolts.

Persons with destructive tendencies have been known to throw monkey wrenches in the social, industrial and economic works. This is not recommended. If more people throughout the world were kind to monkey wrenches, and used them for the purposes for which they were intended, a lot of monkey wrenches and a lot of people would be a lot happier.

Customers bought \$800,000,000 worth of Cities Service products and services last year—more than ever before in history. This growing customer acceptance, we think, is due to the fact that the 40,000 Cities Service employees and dealers use their monkey wrenches constructively.*

*1946	\$333,175,447
1950	\$693,384,685
1951	(est.) \$800,000,000

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COURTNEY C. BROWN

Dinner Meeting

THURSDAY EVENING,

NOVEMBER 8, 1951



Harris & Ewing

M. S. SZYMCAK

JEREMY C. JENKS, President of the New York Society of Security Analysts, presiding.

President Jenks: Honored guests, ladies and gentlemen: This Eastern Regional Conference of the National Federation of Financial Analysts Societies has been sponsored by the New York Society of Security Analysts, as our contribution to the progress of our profession. We are delighted that so many members of the out-of-town Societies are attending today and specially wish to thank our many friends in the Boston and Philadelphia Societies, who are here, for their support and interest.

NEWLY FORMED RICHMOND SOCIETY

I understand that all of the affiliated Societies of security analysts are represented, and I might also mention there are several members with us from the newly formed Richmond Society of Security Analysts. (*Applause*)

Our sincere thanks go to the busy men from industry who spoke at our forums. I know that all of you found, as I did, that these talks were extremely illuminating and full of interest. The discussions of new technological developments in various industries contributed immensely to our knowledge. These gentlemen gave freely of their time and effort, and we are much indebted to them.

Speakers at the luncheon deserve our gratitude and thanks. I think you will all agree that their remarks have clarified our understanding of the significant problems facing business and finance.

Before proceeding with the important talks of the evening by our two guest speakers, I wish to introduce some of the people at the head table. I would like to ask each of them to stand as I mention his name.

SIDNEY LURIE PROGRAM CHAIRMAN

A large part of the hard work in arranging this program fell to Sidney Lurie, the program chairman of this meeting and of the New York Society of Security Analysts. (*Applause*) He was ably assisted by an excellent committee, and I should also mention, as I know he wants me to, that the chairmen who conducted the various forums today were instrumental in securing many of our speakers. We are greatly indebted to the chairmen of these forums.

Sitting next to Mr. Lurie is Mr. Trapnell, President of our Philadelphia Society. (*Applause*)

Next to him is Mr. McLaughlin, President of the Montreal Society. (*Applause*)

George Blauvelt is President of the Cleveland Society. (*Applause*)

Sam Jones is a past president of the Philadelphia Society. (*Applause*) And I might add that Sam is a great worker in the various analysts' affairs.

Kennard Woodworth is known to almost every one of you in this room. (*Applause*) He was the first President of the National Federation and one of the active members and former president of the Boston Security Analysts Society.

On my far right is Mr. Bennett, who is prominent in the Los Angeles Society. (*Applause*)

Next to him is Lucien Hooper, who is familiar to you. (*Applause*) He is known to almost everyone in this room as the second President of our National Federation and past president of our New York Society.

Next to him is John Curley, a valiant worker from the Boston Society. (*Applause*)

Leonard Jarvis is a past president of our New York Society. (*Applause*)

George Hansen is a past president of the National Federation. He is currently President of the Boston Society of Security Analysts. (*Applause*)

I will pass the other people at the head table for the present, as we are going to hear from each of them later on.

Our thanks go to Mrs. Morrison Parker of the Republican County Committee for our seating lists for the dinner today. There are many others who should be mentioned, since they have contributed greatly to the success of this conference. In the interest of getting on with our program, however, I will simply make it a blanket of sincere thanks to all of them.

PIERRE BRETEY, FEDERATION PRESIDENT

I want to introduce to you Pierre Bretey, President of our National Federation of Financial Analyst Societies and one of the past presidents of our New York Society of Security Analysts. He is, as you all know, editor of our ANALYSTS JOURNAL. He has been a pillar of strength in our analyst affairs. Pierre! (*Applause*)

* * *

Pierre Bretey: Ladies and gentlemen: The task which has been assigned to me is a most pleasurable one. It is my privilege to pay tribute to one more responsible for the growth of this Society, for the growth of its JOURNAL, and for the success of our various Federation and regional dinners than any other single individual member of our organization. There have been few of us who have been as dauntless in our efforts to further the success of all of our endeavors as has she.

PRESENTATION TO HELEN SLADE

It seems particularly fitting that we should take cognizance of Helen Slade's labor for us and provide her with something tangible, representing only a small measure of our appreciation. Helen, would you come up to the podium, please? (*Rising ovation*)

On behalf of your committee, your officers, and your Society, it gives me great pleasure to present Helen this silver bowl and tray.

(Pierre Bretey presented a magnificent silver bowl and tray to Helen Slade, for which she gave hearty and surprised thanks.)

Ladies and gentlemen, you all know that we are going to have our next National Federation meeting in San Francisco. It is very fitting that Dick Lambourne, past president of the San Francisco Society and the present executive vice-president of the National Federation, should sound off and tell us about our jaunt to the West Coast next May. It is my pleasure to have Dick tell you all about it. Dick! (*Applause*)

* * *

Richard W. Lambourne: Thank you, Pierre. Mr. Chairman, fellow analysts, ladies and gentlemen: It is always a privilege to attend these fine meetings in the city of New York. The Eastern Regional Conference, I am sure, has been a wonderful experience for all of us. The New York Society of Security Analysts should be highly commended for the quality of the speakers and the program we have had today.

FIRST NATIONAL CONVENTION OUTSIDE NEW YORK

However, those of us from the hinterland—and I include the West Coast in that—recognize the great leadership of these eastern Societies in advancing the analyst profession and in the progress of our National Federation. But next year it is up to us in the West to lead the way for the first national convention to be held outside of New York City. We believe that this will be another important step in further welding the twelve societies into a truly national organization.

We can promise you that the 1952 Convention in San Francisco and Los Angeles will not only keep to the high standards that have been set in the past, but will also provide you with a splendid opportunity for field research into the many growing industries and companies of the West.

Most of you have already seen the folder reprint from the ANALYSTS JOURNAL, giving the outline of the two-day program in San Francisco and the schedule of field trips which will follow for the rest of the week in the Bay Area in Los Angeles and in the Pacific Northwest.

I cannot overstress the remarkable opportunity that all of you will have to hear and meet the top management of western industry. Without taking time to give you full details now (because, over the coming months, you will receive them in copious quantities), let me say that the program and field trips will include, among other things, transcontinental railroads; electrical and natural gas utilities; nonferrous metals; pulp, paper, timber, and plywood; oil and petroleum chemicals; banks, insurance, and investment companies; television, motion pictures, and electronics; food packing; machinery; and aircraft. And, by no means least, the beautiful vineyards and wineries of Northern California. (*Applause*) No matter what your special field of interest may be as an analyst, you will find it in the week of events next May on the West Coast.

A word or two about the dates would be appropriate here, May 4 to May 10. Some of you may have desired an earlier date or perhaps a later time, say, in June. I want to assure you that this question of dates was examined from all viewpoints. We are convinced that early May in California is the best possible choice we could have made and that it meets with the approval of the majority of analysts from all of the Societies. The weather should be perfect and the springtime scenery unsurpassed. You will find it a wonderful time of the year for a convention, for a tour, and for a vacation, if you want to combine the three.

CALLS FOR CAREFUL ORGANIZATION

This undertaking calls for a careful organization. We cannot do it alone. Therefore, committees are being formed in all of the Societies on field trips, publicity, registration, arrangements, and program. I am glad to tell you that we are receiving the strong support and generous aid from all of the Societies from coast to coast. The membership of these committees will be released at an early date. Through them we will keep you fully informed on convention developments.

GREETINGS FROM WEST COAST

I would like at this time to bring greetings to you from Mr. John Beckett, the President of the Security Analysts of San Francisco; from Walter Podolack, President of the Los Angeles Society; from Philip Fitzgerald of San Francisco, who will be program chairman; and all of us in the West who are working to make the convention next year an outstanding event. They join with me and with Pierre, Helen Slade, Kennard Woodworth, Jeremy Jenks, and others in the East in saying not just, "California, here we come!" but, "For the best, come West in 1952!" (*Applause*)

* * *

President Jenks: Thank you, Pierre and Dick. I am sure that it will be unequaled—now and in the future. (*Laughter*)

I am delighted to have the opportunity of introducing to you one of the great authorities on finance and monetary policy. Our speaker is, in point of service, the senior member of the Board of Governors of the Federal Reserve System and has served in this important post for eighteen years. Until recently he has been the United States representative on an international committee to study and review

the compensation and duties of the directors of the World Bank. Governor Szymczak is an active alternate member of the National Advisory Council, which co-ordinates our international financial policy with our domestic policy. He was Economic Director of our Military Government in Germany and in 1944 was in London for the Foreign Economic Administration in reference to Belgian reconstruction plans.

Before becoming a member of the Board of Governors of the Federal Reserve System he was a banker in Chicago, Comptroller of the City of Chicago, and professor at the College of Commerce of De Paul University in Chicago.

Our speaker's many honors and attainments are too long to list. It is a great privilege to be permitted to introduce to you Governor M. S. Szymczak, member of the Board of Governors of the Federal Reserve System, who will speak on formulation of monetary and credit policies. Governor Szymczak! (*Rising ovation*)

* * *

M. S. Szymczak: Mr. President, ladies and gentlemen: I thought I had a speech prepared, and I heard that there was going to be a discussion of the subject of disarmament at the United Nations, and I heard that the President was to speak last night, and so my speech had to wait until I heard what the President said and also read this afternoon the outcome of the proposals in the United Nations on disarmament.

ECONOMY KEEPS CHANGING

As you know, a member of the Board of Governors of the Federal Reserve System is in a position quite similar to yours. As security analysts, you are aware of the fact that our economy keeps changing. There are various influences within our economy, pressures upward and downward, that must be watched continuously. And, if we as a Nation would be strong for the sake of world peace, we must first be strong economically. Our most powerful instrument for world peace is our economic strength, and economic strength, in your opinion and in mine, means economic stability at as high a level of production and employment as is possible.

MUST BE ECONOMICALLY STRONG

If we would have disarmament, world disarmament for world peace, then too we must be economically strong. If we would have strong defenses in order that we might have world peace, then too we must be economically strong. Our strength as a Nation is in our economy, and that we must preserve if we would finally attain world peace.

Therefore, from time to time you and I must review economic developments.

At a time such as this, it is imperative that we take another look at our economic picture—past, present, and even the future, insofar as this is possible. We all recognize the vital importance of maintaining economic stability at a high level of production and employment in order to succeed in our efforts to build a strong defense for world peace and to succeed in our efforts at the United Nations for disarmament for world peace.

As we know, the large wartime growth in liquid assets

provided the underlying basis of the inflationary threat which haunts not only the present defense economy but also has been a real threat to economic stability over most of the past decade. A renewed upsurge of these inflationary pressures occurred with the outbreak of the Korean war. At that time production and employment were at record peacetime levels, with total national production in the second quarter of 1950 running at an annual rate of \$275 billion and nonagricultural employment amounting to almost 44 million. Unemployment amounted to only slightly over 3 million. In steel, automobile, nonferrous metals, and other key industries, capacity was highly utilized. Credit was expanding rapidly, with bank loans in the year preceding Korea rising almost \$5 billion. Prices were moving upward, with the consumer's price index advancing from about 168 in January 1950 to over 170 in June; and the wholesale price index rising from 151 to 157 in the same period. This was a vastly different situation from that existing at the beginning of the World War II period. In the second quarter of 1939 our total national product was \$89 billion on an annual basis, nonagricultural employment was under 30 million, and some 9½ million people were still unemployed. The consumer's price index stood at 99, and the wholesale price index at 76. There was thus much apparent room for expansion.

SEQUENCE OF INFLATIONARY DEVELOPMENTS

Our action to repel the Korean invasion, as well as the urgent necessity for strengthening our defenses, unleashed a sequence of inflationary developments. Initially, in the second half of last year, increased expenditures for goods and services were made largely by private individuals and corporations rather than by public agencies. Consumers reacted to the renewed world crisis by expanding purchases in anticipation of shortages and price advances. Businessmen increased their orders for inventories and sharply revised upward their programs for expansion of plant and equipment. Anticipatory buying forced up the prices of many basic materials. From the second quarter of last year to the first quarter of this year, private spending increased at an annual rate of \$31 billion, while governmental spending was up by only \$13 billion. To some extent, these private expenditures were associated with the needs of the defense program, but nevertheless the major immediate factor in the inflation was the expansion of private, non-defense demands.

BASIC COMMODITY PRICES ADVANCED

Under the pressure of these greatly enlarged demands, basic commodity prices in the first month after Korea advanced 12% and wholesale prices 5%. A cumulative upward spiral of prices, wage rates, incomes, and expenditures was set in motion and continued until the spring of 1951. Basic commodities showed an average increase of about 44%, and consumer prices increased about 9% in this period. Consumer and business incomes increased sharply with the expansion of employment, output, prices, and wages. Personal incomes increased by about 12%, while corporate profits before taxes also rose sharply to a new high during this period. The growth in the current income of consumers and businesses was supplemented by

increased use of liquid assets and credit to add substantially to the inflation process.

REQUIRED PROVISION FOR DEFENSE PROGRAM

Thus, we were in a situation that required provision for the tremendous needs of the defense program while at the same time requiring the restriction of inflationary pressures. Production had to be greatly expanded, and nondefense demand for goods and services had to be restricted to match the output of goods and services available after defense requirements had been met. These were the issues facing the economy. These were the factors that required evaluation by the Federal Reserve System in terms of the over-all monetary and credit policies that would be appropriate for the occasion. The general problem was one similar in kind, if not in degree, to that constantly being faced by central banking institutions: how to adjust monetary and credit conditions to current changes in the economic situation. The short-run problem was (and is) not only the adjustment of monetary and credit policy so that it did not in itself contribute to economic instability, but also the formulation of policy that would help to counteract or compensate for unstabilizing forces.

INTERRELATION OF MONETARY AND FISCAL POLICY

Credit and monetary policy alone does not afford a solution for all our economic difficulties. It cannot offset all the destabilizing forces in the economy, and thus it requires the aid of fiscal policy and other governmental action. Both fiscal and monetary policy can affect the aggregate demand, that is, the total volume of spending, in the economy. Fiscal policy is primarily effective through its influence on the volume and kind of governmental expenditures on the one hand and the amount and kind of taxation on the other. Thus, governmental expenditure may be directed at different segments of the community with varying results. Some expenditure, as public outlays on various free services such as roads, parks, education, and health programs, may act to increase private consumption. On the other hand, the outlays may be for investment purposes, as resource development, public housing programs, and Government lending to finance private housing, rural electrification, and various forms of private industry. The development of such expenditure programs brings up familiar but pertinent questions. How far may such expenditures expand without coming into competition with private industry? If Government expenditures are designed to be noncompeting with the private sector of the economy, how far can they expand before the social benefits of such expenditure diminish greatly—especially when compared to the alternative use of these funds by the private sector? It is also true that many potential areas of Government investment do not readily lend themselves to the abrupt changes necessary in a flexible stabilization program. The spigot is not readily turned on and off.

AMOUNT AND KIND OF TAXATION SIGNIFICANT

The amount and kind of taxation is especially significant, as the burden of over-all taxation in the Nation grows and tax rates again approach or pass their World War II peaks. Not only does taxation act to reduce personal incomes, but

also, as you know, the combination of taxes and expenditures results in a redistribution of total income after taxes. The progressive personal income tax is especially important in this connection. Such a redistribution of income results in a change in the pattern of private buying and spending and, in this respect, is similar to excise taxation, which also affects the pattern of consumer expenditure. The problem of timing is important, in taxation as well as in expenditure, and the recent session of Congress indicates the amount of time necessary to obtain passage of tax legislation. Some taxes, such as the income taxes, however, have "built-in flexibility," which provides some stabilization effects through yield changes as levels of income fluctuate. It should be noted here that these fiscal devices are similar to general monetary policy in that they are measures taken by public authorities. In both cases they affect private spending through the market mechanism and thus operate in an impersonal fashion.

FISCAL POLICY MAY RESTRAIN INFLATION

Fiscal policy may be used to restrain inflation through the reduction of Government expenditures or the increase of taxes, or both. The most direct and effective way to curtail inflation is through taxation. Taxation also makes people conscious of Government expenditure and the purpose of such expenditure. Taxation tends to reduce the amount of disposable income available for private expenditure and thus helps to prepare an economic climate in which monetary and credit policy can be more effective. As taxes climb higher, however, the question of how high our taxation can go without impairing the functioning of our free enterprise system becomes more and more significant. Also, some taxes themselves may be added to costs and thus be reflected in higher prices to consumers and in the price indexes, which are used as criteria for further wage increases.

MUST BE DIRECTED TO SAME OBJECTIVES

It is therefore evident that monetary and credit policy and fiscal policy must be directed to the same objectives, in order to avoid offsetting each other, and also in order to maximize their effectiveness in facilitating the attainment of stable economic progress. The combination of fiscal and monetary policy that is most desirable at any particular time will depend on the existing economic situation as well as the practical feasibility of various actions. Credit and monetary policies and fiscal policies are both complementary and mutually supplementary instruments of public policy, which must be used together to assure stable economic progress.

THE FUNCTIONS OF MONETARY POLICY

Keeping in mind these important relationships of monetary and fiscal policy, let us now turn to a more careful examination of the functions of monetary and credit policy. The objective of monetary policy is the maintenance of the amount of credit and money in the economy that will contribute to stable economic progress at high levels of production and employment. All the various instruments of the Federal Reserve are directed toward this common broad objective. Each instrument, however, operates through dif-

ferent channels and is designed to accomplish somewhat different specific objectives.

PRINCIPAL TOOLS AVAILABLE

The principal tools available to the Federal Reserve for accomplishing these ends are the following:

1. Open market operations, which serve to affect the volume of bank reserves at the initiative of Federal Reserve authorities. In recent years they also have been used to contribute to the maintenance of orderly markets for Government securities.

2. Discounts and advances to member banks, which allow member banks, on their own initiative, to make necessary short-run adjustments in their reserve positions.

3. Reserve requirements, which are established within statutory limits by the Board requiring member banks to hold certain reserves relative to deposits.

4. Selective credit controls, which are designed to affect credit in particular areas, without necessarily affecting the availability of funds in other areas.

5. Supervisory activities, direct suasion, and voluntary programs designed to influence lending activities in general or in particular credit areas.

The first three instruments—open market operations, the making of discounts and advances, and the setting of reserve requirements—are impersonalized stabilization tools. They operate through the market mechanism of the private economy and, in this way, affect spending.

MAY AFFECT TOTAL VOLUME OF MONEY

Some of these monetary instruments may affect the total volume of money and other liquid assets. Changes in policy thus affect the amount that the economy as a whole has to spend. Other policy instruments may influence the total volume of spending, by affecting that part which is financed through credit extension. Their effect is usually general and indirect, with the immediate impact falling on the cost and availability of credit.

UPWARD OR DOWNWARD PRESSURE

As security analysts, you know that monetary influence on the volume of spending is also exerted by upward or downward pressure on the value of marketable assets. Such pressure affects the amounts that various investor groups would receive for their assets. For example, an increase in yield from $2\frac{1}{2}$ to $2\frac{3}{4}$ % on a twenty-year $2\frac{1}{2}$ % security involves a decline in price from 100 to slightly over 96. It thus may affect investors' readiness to sell assets in order to obtain cash and thus tends to reduce their propensity to spend.

Another method of influencing spending is through the regulation of terms under which borrowers obtain credit. Thus special regulations apply to loans on stock exchange collateral, consumer credit, and real estate credit—types of credit that lend themselves to standardized patterns that can be singled out by statute for regulation. The raising of margin requirements to 75% in January of 1951 limited the amount of credit that can be extended on listed securities. From January to August of 1951, customers' debit balances have declined \$150 million. In September these

balances totaled \$1,290 million. The regulation of consumer credit through regulation W has exerted a definitely restraining influence—installment credit outstanding was reduced by half a billion dollars from October 1950 to July 1951. The Board's regulation X covering down payments and maturities in the real estate field has been increasingly effective throughout 1951. In the third quarter of the year, housing starts were below the level of the previous year by over 35%.

HELPS DETERMINE FINANCIAL CLIMATE

Finally, as you well know, monetary policy helps to determine the general financial climate of the Nation. When the money market (that is, credit and money) is "easy," the effect is the establishment of a favorable financial climate for the expansion of business, investor, and consumer expenditure. If the market is "tight"—the financial climate is less favorable—the tempo of spending activity is dampened, and caution appears in sensitive business areas.

STABLE AND SMOOTHLY FUNCTIONING ECONOMY

These pressures and influences on the volume of spending, when applied in an appropriate fashion, make their contribution to the attainment of a stable and smoothly functioning economy. In the light of any given economic situation, however, such as the afore-mentioned inflationary impact of the defense economy, appropriate action demands flexibility of policy so that changes in economic conditions can be met as quickly as possible. Likewise, in order to achieve long-run goals, an informed, watchful, neutral policy is very important and, for obvious reasons, at times very difficult.

This brings us back specifically to the problems occasioned by the Korean war and the development of a defense economy—a period when there were many questions to be answered and steps to be taken.

CREDIT AND MONETARY POLICY IN THE DEFENSE PROGRAM

At the risk of being repetitious, I believe it is necessary and important to review, at this time, what has happened in the fight against inflation. On the basis of this broad sketch of the role of monetary and credit policy in our modern economy, what actions were taken to develop an anti-inflation program? Some criticism may be levied against the program because some actions were not taken more promptly or more vigorously. It should be recognized, however, that the problem of reconciling security and private demands was, and is, much more difficult than at the start of World War II. There were inevitable lags in shifting from a normal peacetime to a defense economy. Congress acted with considerable dispatch in the case of some programs. The Defense Production Act was approved in early September 1950, and some of the curbs permitted by that act were in operation in October. A variety of financial actions, designed to reduce spending for nondefense purposes, were necessary, and many of these have been taken. Nonfinancial controls, such as the materials allocation program, and price and wage control have acted to relieve and limit pressures on prices.

General credit measures designed to limit the supply of

lendable funds available—particularly to banks—have been used, with considerable success. These measures include changes in discount rates, in open market operations, and in bank reserve requirements. As you will remember, in August 1950, the Federal Reserve Board and the Open Market Committee issued a joint statement, indicating that they were prepared to use all available powers to restrain further expansion of bank credit consistent with a policy of maintaining orderly conditions in the Government securities market. Discount rates were increased from $1\frac{1}{2}$ to $1\frac{3}{4}$ %. Open market operations were so directed as to reduce System purchases of Government securities and thus limit the availability of reserves to banks. As a result of these operations, short-term rates rose slightly. However, the System continued support of the long-term bond market which tended to offset the effectiveness of these policies. Federal Reserve purchases of securities in these support operations were only partially offset by sales of other issues in the market; and, as a result, banks obtained additional reserves which provided the basis for further bank credit expansion.

Some of these additional reserves were absorbed in January 1951, by an increase in member bank reserve requirements. For banks that did not have excess reserves, however, this necessitated the sale of Governments, in order to obtain the required reserves, and this, in turn, placed pressure on the securities market, and thus required buying by the Federal Reserve.

ADOPTED OPEN MARKET POLICIES

Last spring, however, the Federal Reserve adopted open market policies to minimize monetization of the public debt, while maintaining orderly conditions in the Government securities market. Since then, the Government bond market has functioned more nearly as a normal market mechanism, without Federal Reserve support, except for temporary operations to facilitate Treasury refundings. Reduced availability of credit, in the face of insistent credit demand, necessarily implies a somewhat higher level of interest rates in various sectors of the market. If we take April as a base, short-term interest rates since then have ranged from $\frac{1}{8}$ to $\frac{1}{4}$ % above that level but at the present time are near the levels that prevailed at the end of April. Long-term rates have followed the same general pattern of flexibility.

ANTI-INFLATIONARY INFLUENCE

In addition to these general controls, the selective controls that I have already mentioned have exerted an important anti-inflationary influence in key markets. Installment credit has been reduced, and the mortgage market has tightened, in response to Federal Reserve activity.

In this situation, voluntary credit restraint or lender co-operation has also played an important part. This program is a striking illustration of the way in which a complex voluntary effort can be successfully organized to keep lenders and borrowers, public and private, constantly informed about and alert to monetary and credit conditions and to help evaluate loans that are nonessential and should be curtailed.

In addition to these shifts in credit and monetary policy,

the Nation, in the period of a year, was subjected to a much heavier taxation program. In order to meet rapidly mounting defense expenditures and curtail inflationary pressures, unprecedented tax increases were necessary. In a period of a few months, Congress adopted taxes designed to add some \$10 billion, on yearly basis, to Federal Government receipts. This was accomplished by the Revenue Act of 1950 and the Excess Profits Tax of 1950. The President has recently signed the Revenue Act of 1951 which will add some \$5 billion more annually to receipts. Individual income tax rates are now near the peak levels reached during World War II. Corporate income tax rates for most corporations are at new highs, and these recent increases, plus excess profits taxation, have sharply increased the overall corporate tax rates. These increased taxes have meant that private income after taxes, and thus private demands, has been substantially less than it would otherwise have been.

EFFECTIVENESS DIFFICULT TO MEASURE

The effectiveness of such monetary and fiscal policies, as well as of nonfinancial restraints, is always difficult to measure, because it has to be appraised in terms of what would have occurred if the policies had not been adopted. There is definite evidence, however, that these anti-inflationary programs, together with other nonfinancial programs, have had marked beneficial effects. Prices of basic materials are well below their earlier speculative peaks, wholesale prices generally are moderately lower, and consumer prices have shown little change since spring. Despite further increases in personal income, there has been a noticeable slackening in consumer demand from the extraordinary levels reached earlier in this period. Personal saving has risen to the highest level since the end of World War II. In recent months, liquid saving, in the form of time deposits and saving and loan shares, has increased markedly. Production has been maintained at high levels, and, with consumer demand slackened, readjustment to defense production has been accelerated. We have also made great strides toward the achievement and maintenance of military might. The defense program has made important progress toward establishing and equipping a military force of about $3\frac{1}{2}$ million, providing a stockpile of critical materials and sufficient military material for near-term needs, establishing a large production potential in basic and defense industries, and supplying other free nations with some armament for their armed forces.

PROSPECTIVE DEVELOPMENTS IN CREDIT AND MONETARY POLICY

With these events and real achievements behind us, it seems proper now to consider at least some of the problems of the future. From an over-all point of view, the events of the past six months have formed a mixed pattern of demand and price developments. Thus, although defense expenditures rose at an annual rate of \$12 billion, from the first to third quarters of 1951, nondefense expenditures, mainly private, dropped by almost \$5 billion.

The current economic situation, as I have said, is essentially one of stability at very high levels of production and employment. The gross national product has been holding

at an annual rate of roughly \$325 billion for the past two quarters while personal income has increased only slightly—from an annual rate of \$250 billion in the second quarter to about \$253 billion in the third quarter. Consumer prices have remained relatively stable since spring at advanced levels about 9% above the pre-Korea level. Wholesale prices have been fairly stable at a level about 4% below the March 1951 peak but still 13% above June 1950 levels. The prices of basic materials, which rose very sharply from the summer of 1950 to the early part of 1951, declined considerably from March to July and then showed little change to mid-September. Since then, prices of some materials, especially metals, have returned to or close to their peak levels. Nonagricultural employment has remained stable since March—holding roughly to a figure of 46.5 million.

SOFT SPOTS HAVE DEVELOPED

Soft spots have developed in some areas of the economic scene, especially for household durable goods such as appliances and furniture. Also production of leather, textiles, and some other nondurable consumer goods outstripped demand; inventories of these goods accumulated and are now being reduced. There have been pronounced efforts on the part of business to reduce excessive inventories in many consumer lines.

THE SHORT-RUN PROBLEM

Does the development of these and other soft spots mean that inflationary forces are spent and that we can relax our vigilance and shortly dispense with part of our anti-inflation weapons? This is the short-run problem that we face. The President, in his speech last night, warned that a crisis still exists when he said: "In making our proposal for reducing armaments, we are not suggesting that the crisis in world affairs has passed, or even that it has lessened. It has not. We cannot afford, for one minute, to let down our guard, or falter in our defense program."

FORCES SHAPING ECONOMIC DEVELOPMENT

Even if the disarmament plan is eventually successful, it will take a long time to implement such a program. Thus, it is necessary to look beyond the immediate situation to the basic forces which will shape the Nation's economic development for the next few years. As we understand it, our national security program goes beyond the immediate requirements of Korea. Expenditures for this program, including foreign aid, have increased from an annual rate of \$16 billion just preceding Korea to one of about \$40 billion for the quarter just passed. The Third Quarterly Report to the President by Director of Defense Mobilization Charles E. Wilson estimated that defense expenditures would rise by another \$25 billion in the coming year and would increase still further thereafter. For example, production of aircraft doubled in the past year, but it is expected to increase four to five times more than present levels in the next two years. Large increases in deliveries are also scheduled for tanks, guns, ammunition, and for highly complex and expensive electronics equipment. Outlays for defense purposes now take about 13% of total output, and a year from now are expected to take 18 to 20%

of an even larger total output. The increasing needs of the defense program will probably require continuing very large outlays for plant modernization and expansion.

BUSINESS EXPENDITURES AT RECORD RATES

Business expenditures for plant and equipment are currently at record rates. Some estimates for 1951 place the total in excess of \$25 billion, compared to \$18.6 billion for 1950 and \$19.2 billion for 1948, the previous peak year. Much of this great volume of expenditure represents expansion of plant and modernization of facilities in defense industries, such as iron and steel, railroads, petroleum, and utilities. The rising volume of defense expenditure and large business expenditures for plant and equipment have been and may well continue to be major expansive factors in the economy.

The additional defense output will also generate additional personal income after taxes, and this larger income may find expression partly in greater demand for civilian goods. Although most goods are in ample supply, acute shortages of steel, copper, aluminum, and other basic metals persist. These shortages have resulted in orders limiting their use for production of many consumer durable goods. Although restrictions on the scale required during World War II are not anticipated, some additional curtailment of civilian supplies of metal products is in prospect. Thus, on the one hand is the prospect of somewhat limited supply of some items and on the other the additional demand potential, arising out of higher personal income.

HIGH PERSONAL SAVING RATE

The danger of increased consumer demands arising from this source may be intensified in view of the recent unusually high personal saving rate. Personal savings amounted to about \$11 billion in 1950 and in the second quarter of 1951 were at the high level of \$21 billion, on an annual basis. In recent months, individuals have been saving more than 9% of their current income after taxes. This is an unusually high proportion and compares with an average of about 4% in the period 1947-50. If consumers spend a more customary proportion of their income, inflationary pressures will be still greater.

Thus, on the basis of these factors, it appears that the economy is still threatened with the recurrence of inflationary pressures, even if the volume of defense expenditure is reduced moderately. Both consumers and businesses are in strong financial positions, and this, together with expected increases in income, could readily support new buying surges or more gradual increases to higher expenditure levels.

Under present circumstances, basic economic policy must still be directed toward maintaining economic stability in a strife-ridden world. It seems to me, therefore, that the Federal Reserve System should take this longer-run view while dealing with the current situation. This is in the long-range public interest. (*Applause*)

* * *

President Jenkins: Thank you, Governor Szymczak, for a most illuminating and inspiring talk.

Our final speaker of the evening is a man known to

many security analysts as a leading student of economics, especially of the petroleum industry, and a man of major attainments and ability. He received his bachelor's degree in economics at Dartmouth College in 1925. After a decade in the investment business, he returned to do graduate work in economics at Columbia University where he received his PhD degree. Remaining as a faculty member, he lectured in economics for four years. In 1941, on a leave of absence from Columbia, he joined the Chase National Bank as an associate director of research. At the opening of World War II he moved to Washington, D. C., where, from 1941 to 1945, his assignments included that of vice-president in charge of foreign activities of the Commodity Credit Corporation of the Department of Agriculture and Chief of the Division of War Supply and Resources of the Department of State. He joined Jersey Standard in 1946 as head of the company's petroleum economics division and is now assistant to the chairman of the board.

It gives me great pleasure to present to you Dr. Courtney C. Brown. Dr. Brown! (*Applause*)

* * *

Courtney C. Brown: As I think of this talk that I have prepared for this evening, I am more impressed with the novelty of the piece. It doesn't use the terms "armament," "inflation," "deflation," "savings" or "investment." It does not even use the terms "Korea" or "Iran." The omission of the former factors I am most grateful for myself, because I am sure that they could not be treated by me with the same skill with which you have just heard them discussed by Governor Szymczak.

SOME NEW IDEAS

Rather, I have tried to go at this task thinking of some of the kinds of questions that I used to be faced with when I shared your work. Rather than making a few estimates of what is going to happen in the oil market, I have tried to provide here some new and possibly novel ideas that will serve you as analytical tools, or, perhaps more exactly, sharpening of some of the analytical tools that are already in your kits.

FEATURES OF THE OIL MARKET

It is good to be back among security analysts. It was once my privilege to be a security analyst, and I know how continuously interested you are to find new facts that might be useful in your work. There are few professions, and I use the term "profession" advisedly, that make more of a call on their practitioners for an intimate knowledge about a wide variety of things. It is my assignment this evening to attempt to sketch in some of the features of the oil market that might be of help in this never-ending effort of yours to analyze the future.

ANALYZING THE BUSINESS CYCLE

I suppose everybody evolves some kind of theory regarding the best way to go about a job he lives with for very long. I was no exception when I was in the security analysis business. It seemed to me then, and I believe I have retained the conviction, that the job of analyzing securities

and their prospects broke logically into three stages. First, there was the stage of analyzing the business cycle. There is an old adage that stocks move up one at a time, but move down all together; and we all know the influence of cyclical money market changes on fixed income securities. Therefore, I considered that my first task was to try, as best I could, to locate myself on the curve of business expansion or contraction, before I was ready to attempt the appraisal of other types of risks.

STUDY OF INDIVIDUAL COMPANIES

Hardly less important, it seemed to me, was the second stage of analysis. Various fields of activities or industries, as you so well know, differ markedly from time to time in their relative prospects within the rhythm of total business activity. Only when the analysis of the total business cycle and of its component industrial parts had been completed, was it time, it seemed to me, to begin the third stage—the study of individual companies, together with their capital structures, financial statements, management capacities, and other unique features.

Of these three stages of analysis, I have been assigned the second for discussion this evening, and even that has been restricted to one industry—namely, the petroleum business. I should like to restrict it still further and talk only about the characteristics of market demand. If, in the elaboration of some of the broader characteristics of the petroleum market, we run into fairly complex ideas, it will merely serve to emphasize the multiple complexity of the task you gentlemen have been willing to assume as a life-work.

MORE INTERESTED IN INVESTMENT

Moreover, I want to approach the subject from the standpoint of an analyst who is more interested in investment than in short-term changes. That means that I will not get into an analysis of the current position of the oil market, nor will I develop the situation as it may appear to look during the coming winter. Mr. David Shepard, executive assistant to the president of my company, is scheduled to do that at one of your luncheon meetings on the 23d of this month, and I am sure that his story will be well worth waiting for. Rather I want to go back and pick up some of the basic changes that have been making themselves increasingly felt in the demands for petroleum over a period of several decades, and describe what I feel may be their significance to one interested in oil securities as long-term investments.

Being a mere economist, and not an engineer, I will not try to get deeply into that part of total demand contributed by the petrochemical business, except to say it is growing spectacularly, it is profitable, but, as an outlet for crude, it is still relatively small.

SUPPLIES

Since this is a talk about petroleum demands, there is one other "not" I should mention. I shall not discuss supplies, except to make two observations. First, it looks as though there should be plenty of oil for a long time to come. We still find more oil every year than we use. It sometimes looks as though all that is needed to find some really big

fields like Scurry County, Sprayberry, and perhaps Williston Basin is another cluster of speeches about running out of oil. Second, it is worth observing that supply operations typically react sensitively, sometimes rather violently, to unexpected changes in the level of demand. Needless to say, that is correspondingly felt in the income account.

HISTORY A GOOD SPRINGBOARD

History is a good springboard, and that is particularly true in thinking about the present nature and future characteristics of oil demands in the United States. It was nearly a hundred years ago that Colonel Drake brought in his famous discovery well. I want to start with a premise—namely, that, in the years that have since elapsed, the U. S. petroleum market has gone through two fairly distinct phases and, in recent decades, has entered a third. Until the beginning of the present century, the U. S. oil market was overwhelmingly a kerosene market—kerosene was used for illumination. There was a little harness-softening business, and an axle grease business, and white oils for pharmaceuticals, and cosmetics had begun to develop. Gasoline was an unwanted product and nuisance. For those of you who are familiar with present-day refinery yields, it is interesting to note that, at the turn of the century, the refinery yield of gasoline on crude averaged an irreducible 11%. Gasoline was then considered the residual product.

SITUATION COMPLETELY REVERSED

With the turn of the century, the situation was completely reversed. The development of the internal-combustion engine made gasoline the backbone of the petroleum market. It became the principal product of the industry. Except for a few specialties, it was the only so-called primary product. Kerosene—along with other distillates and heavy burning oils—came to be regarded as a by-product, and continued to be so regarded until the decade of the 1930's. Each refiner would try to guess how much gasoline he could sell, and his demand for crude was based on the amount needed to obtain that volume, assuming a maximum gasoline yield. Except in rare instances, crude oil was not produced for the refining of kerosene and distillate as such. They, along with the heavy fuel oils and residuals, were the fractions that were left after a maximum cut of gasoline.

THIRD PHASE NOTICEABLE IN 1930'S

A third phase in the development of the oil market began to appear noticeably in the 1930's. Its principal characteristic has been the production and sale of light burning oils, in volumes far in excess of their by-product production. These products are produced today as prime products, which means that their production at the refinery is no longer minimized and that they make their own independent call on crude. Since the realization on residuals is less than the crude cost equivalent, domestic refiners still try to minimize its production, and in all probability will continue to do so indefinitely.

There are several interesting ways in which this new phase in the development of the oil market can be seen. One that may seem a little novel to you, but nevertheless shows an interesting result, is to take the total crude and

product demands for successive summer periods—the six summer months will do—and draw a trend line through them to describe the average rate of summer growth. Then do the same thing for successive winter periods—which can be measured by combining the last and first quarters of successive years. Then compare the trend of the rate of winter growth with the rate of summer growth.

SEASONAL BUSINESS WITH PEAK IN SUMMER

This little exercise shows a seasonal business, before the 1930's, with its peak in the summer. The trend lines then cross, and, since the 1930's, this position has been reversed. The peak now occurs in the winter, and, with the passage of time, the winter peak is getting higher and higher relative to the summer. Demands now average about 500,000 B/D, or nearly 10%, higher during a normal winter than during the preceding summer.

GASOLINE DEMANDS DECLINE IN WINTER

Since gasoline demands decline during the winter, progressively higher winter demands for all products would clearly be impossible if the light burning oils were still produced only as by-products. There would simply not be enough supply. The same thing can be said the other way around. The higher the successive winter peak demands become relative to the preceding summer, the farther are the light burning oils removed from their erstwhile by-product status.

COMPARING RELATIVE YIELDS

A second way in which this new phase in the oil market can be seen is by comparing relative yields in recent years with those that existed, say, in the first half of the 1930's. No doubt you have all heard a great deal about the amount of money that has been put into improved technology. All the catalytic cracking equipment that has been put in place has made it physically possible to get a greater volume of gasoline out of a barrel of crude. But that is not what has happened. There has been a lot of money put in new technology all right, but it has resulted in improved quality—and lower residual fuel output—not in more gasoline per barrel of crude. In the five years 1946–50, the average yield of gasoline on crude runs was actually 2.7% lower than it was fifteen years earlier, during the period of 1931–35. The total middle distillate yield, on the other hand, which includes kerosene, gas oil, Diesels, and light burning oils, was 8.4% higher in the latter period than in the former.

With gasoline yields declining and middle distillate yields increasing, it is no longer appropriate to think of the petroleum business as fundamentally a gasoline business with the predominant characteristics of the gasoline business. It is getting to be a lot more complicated than that.

Still another way to describe this change in the nature of the oil market involves some pretty complicated computation, which I shall not impose on you this evening, chiefly because I do not fully understand it myself. The end result is most instructive, however. Almost all types of growth have a characteristic pattern. That is true, whether it is the growth of a commercial market, the life growth in the weight of an animal or an individual growth

in the population of a country, or what not. In the early stages, the volumetric growth is small. There follows a period of vigorous expansion, after which a gradual tapering off occurs, until a period of stability or decline is reached. A good mathematical description of this pattern is called a logistic curve. Put on a standard arithmetic graph, it usually looks like a letter S, tilted a bit forward. On a semilogarithmic chart, which describes rates of change, the curve usually bulges to the right by moving upward rapidly at the start and flattening out to approach an asymptote at the top. That is a way of saying that successive percentage increases begin to decrease some time before a decline begins in volumetric growth.

FIGURES GO BACK TO 1865

We are fortunate in having access to U. S. crude and product demand figures that go back to 1865. When these successive yearly demands are plotted on a semilog chart and mathematically analyzed, the best fit appears to be two rather than one of these logistic curves. The first reaches an asymptote at about the turn of the last century. That was the kerosene market beginning to peter out. But sometimes a basic change occurs in a growth pattern that provides a new stimulant, perhaps during the tapering-off period, and a new growth cycle begins. That is clearly what occurred at the turn of the century with the appearance of gasoline demand. A new oil market was superimposed on the old. But the second logistic curve begins to show signs of flattening out in the 1930's. It is not too conspicuous, to be sure, but the mathematically computed projection of the curve since the 1930's is well below a plotting of the actual demands that have been made against the industry. Perhaps once again a new growth stimulant has come into the oil market. Perhaps we can again look forward to another large period of growth ahead.

NEW GROWTH FACTOR

From each of the ways you might look at it, the new growth factor has been supplied by the demand for products that come out of the middle of the crude barrel. In the twenty-year period, 1931-50, the compounded rate of annual demand gain for the total middle distillates was about 9%, whereas the comparable rate of gain for gasoline was a little less than 5%, and for residual fuel only 4%.

ENERGY FOR STATIONARY USES

It is interesting to observe that, whereas the petroleum business has long been thought of as a business whose principal job is to supply energy for transportation, the fact of the matter is that, for the past two decades, it has been increasingly supplying energy for stationary uses. Although the railroad market for Diesel oil has grown spectacularly, as you all know, the largest outlet for the middle fractions has come from use in stationary equipment. You can see how that might be the case when you stop to think that a portable space heater that costs \$100 to \$150 may consume as much petroleum in a year as an automobile that costs \$2,000 to \$4,000. Or, again, a power burner to heat a home costs about one fourth as much as a low-priced automobile but consumes three times as much petroleum. Twenty-five years ago, there were fewer than 200,000 oil

burners in the United States. Today, there are well over 5 million.

WOULD SHOW DECREASED GROWTH

Were it not for this new stimulant that came noticeably into the oil market two decades or so ago, the petroleum business would today probably have begun to show more evident signs of a decreased rate of growth. In part because of the great efficiency of the Diesel engine, and because of some increase in efficiency of motorcars, the use of energy in all its forms, by transportation, also in all of its forms, may not increase very greatly in the years ahead—perhaps less than 1% a year over the next ten years. If that is correct, it is a very important conclusion, for it represents a slower rate of gain in total transportation use of energy than has been experienced in the past.

GROWN RAPIDLY FOR TWO REASONS

Petroleum, in contrast to other forms of energy used by transportation, has grown rapidly in the past for two reasons. The transportation industry's needs for energy have grown, and oil has supplied a progressively larger share of the prime mover. Now, the major part of the transportation energy market has already been converted to the use of petroleum, and an efficiency factor is reducing the energy needed for a given amount of work. For these reasons, it is possible that henceforth the opportunity for further substantial growth in transportation use of petroleum may not be so great as it has been in the past.

A VAST MARKET

On the other hand, when we look at the demand for energy in all of its uses, including stationary uses, we get a very different picture. Potentially, the stationary use of energy provides a market vastly larger than the transportation market on which the petroleum industry's past growth has been so largely built. In 1950, transportation use of energy was less than 25% of the total. Highway use was only about 12%. Heating, the firing of boilers, or other industrial uses made up better than 75% of the total.

The oil business began, several decades ago, the transition from a business whose principal reliance has been on gasoline into the status of a diversified business in which burning oils as a group have come to be of prime importance. By so doing, it opened up the possibility of future great growth. It is this new stimulant to demand that may have already started the industry on a third phase of its historical development.

In retrospect, the oil business in a sense has been three different businesses. It was a kerosene business before the turn of the century. It was a gasoline business for the first quarter of the twentieth century. In the second quarter of the twentieth century, it moved in the direction of becoming a diversified energy business. It now looks as though that characteristic will continue to develop in a pronounced manner. Since it is a competitive business, this is only natural, for the competitive process invariably leads an industry into those channels in which the greatest growth seems probable.

It would be a mistake, however, to think that these developing characteristics are to be realized without some ac-

companying difficulties. In any phase of life, a cost is usually involved in every step forward. In the oil business, we are in a sense buying the prospect of large future growth at the expense of some of our past stability. In the years to come, I do not believe that we can expect the demands for petroleum to exhibit the same high degree of stability that was characteristic of demand when gasoline was the only prime product. By comparison with some other great industries, I believe our future demands may be relatively stable, but, by comparison with past experience in the oil business, I believe we will find that we will have lost some of the stability we once enjoyed. There are a number of reasons for this.

SEASONAL CHARACTERISTIC OF DEMAND

The increasingly conspicuous seasonal characteristic of market demand has already been mentioned. This has a number of troublesome consequences. Any seasonal business, whether it is the oil business or another, can meet its peak demands in one of two basic ways. It can produce and store products in the slack season for delivery during a subsequent period of peak demand. Apart from the cost of carrying the inventory, that involves a good deal of risk, unless it is possible to forecast fairly precisely the magnitude of demands in the peak period ahead. A bad guess on the high side would leave the industry with burdensome inventories after the peak demand has passed, with the usual result on prices. On the other hand, a bad guess on the low side would result in inadequate supplies at the period of peak demand. The penalties of political and public criticism that would result from that type of situation could be very serious indeed.

HOW PEAK DEMANDS MIGHT BE MET

The other way in which peak demands might be met is to provide adequate supply capacity for peak requirements at all functional levels of the industry. That may be the safer way, but it is also by far the most expensive. It means that a large part of the productive capacity must be idle during the slack season. Of course, a combination of these two ways of meeting peak demands is usually worked out.

IMPLIES PRICE FLEXIBILITY

In the oil business, which is a joint product business, we have a third way. Within limits, product yields can be shifted from one product to another, depending on the seasonal demands. This implies price flexibility, however, if these seasonal shifts in refinery yields are to be made without financial penalty; and as you know, with Government price controls, we do not have price flexibility today.

In addition to the greater storage required in refinery tanks and bulk terminals, distributors and other types of re-sellers also usually build up their summer storage of kerosene and home-heating oil in anticipation of the following winter. In the oil business, as in most businesses, dealers typically operate with limited capital. Their storage, which is usually called secondary storage, is a highly uncertain factor, and sensitive to psychological influences, including changes in price expectations.

Normal seasonal variations in these secondary stocks, in-

cluding consumers' tanks, do not constitute a problem, but the frequent departures from normal do. Factual information regarding the stocks is very scanty. There is evidence, however, that the changes in these secondary inventories represent very large volumes. It is believed that just normal seasonal fluctuations may amount to some 25 million barrels, and departures from such a large undisclosed change can be very significant when translated into demands made against refinery supplies.

DIFFICULTY OF PREDICTING DEMANDS

With the growth in the use of petroleum for heating, the difficulty of predicting petroleum demands is made no easier by the uncertainties of weather. A 5% warmer winter or colder winter than normal could make a difference of some 2000,000 B/D in the level of winter heating oil demands. That is an important difference; yet we know very little that is reliable about long-period weather forecasting. Precipitation is of some importance, for its effect on motorcar driving and on the use of oil in place of hydroelectric power. Even wind is an item. However, it is temperature that is of prime concern to the petroleum industry.

WEATHER FORECASTING

Approaches to weather forecasting are usually either statistical or meteorological or both. A considerable amount of work has been done to try to determine whether any long-term trends or cycles in weather could be statistically demonstrated. Unfortunately, the results have been inconclusive.

LONG-RANGE FORECASTING IN EARLY STAGES

Long-range weather forecasting, based on the science of meteorology, is still in its early stages. Varying degrees of success have been attained, but it appears fair to say that no methods of adequate accuracy have yet emerged.

Still another reason why the oil business of the future is likely to be less stable than it was in the past is that some of the developing characteristics are expected to make petroleum demands more sensitive to changes in the general level of business.

NOT SENSITIVE TO CYCLICAL CHANGES

I should not expect the oil business ever to become as sensitive to changes in business cycles as other important businesses—as steel or heavy equipment, for example. Petroleum demand has demonstrated a remarkably consistent growth over the years. However, it did turn down with the business depression in the years 1930–32. This experience was repeated when in 1938 domestic demands were less than in 1937. Although 1949 demands were just about the same as they had been in the preceding year, there was evidence of a sensitiveness to the mild business decline that occurred in that year. And it is interesting to observe that, although 1949 demand was about even with that of 1948, supply operations showed no such stability. There was a decline of about 1 million B/D in the rate of crude production from the peak month of 1948 to the low month of 1949.

Such statistical evidence as we have been able to de-

velop begins to suggest that the demands made against the petroleum industry will henceforth be somewhat more responsive to changes in the general level of business. This is as one would expect. Apart from heating, the nontransportation uses for petroleum tend to expand or contract with business activity, and even some of the marginal motorcar driving may be more affected in the future than it has been in the past.

Finally, there is another reason why we may expect this shift in the nature of the petroleum market to result in greater difficulty of prediction. In the transportation field, oil has had pretty much the run of the market, because of its greater efficiency and convenience. That is not nearly so true in stationary uses where oil must meet competitive energy sources, some of which are quite as convenient as liquid fuel. Natural gas is an example.

The additional natural gas presently scheduled to arrive in eastern and midwestern areas over the next few years is equivalent to about 300,000 B/D of crude. Of course, only part of this will actually displace liquid fuel, with the remainder displacing coal or supplying a part of the added energy requirements. What the ultimate division will be is only partly subject to analytical treatment. But we can tell pretty clearly that, because of the peculiar nature of the natural gas market and the combined practices of so-called "peak shaving" in the winter, and of selling dump gas in the summer on an interruptible basis, the demands for other fuels, including petroleum, in the winter will be pushed even higher relative to the summer than they are now. In other words, one of the effects of natural gas will be to make the petroleum market still more seasonal.

In addition to natural gas as a competitive fuel, the oil business must be aware of still other sources of energy that may come into the picture in the years ahead. Three that are still in the experimental stage are potentially important: the heat pump, solar energy, and atomic energy. Each of these today is inhibited by large initial investment costs or other difficulties. But technology is a wonderful thing, and somewhere along the line we should not be surprised if we find each or all of them becoming commercially feasible. Particularly, the outlook for the use of atomic power in certain types of installations appears promising, although not immediate. Owing to both economic and technical limitations, there is not too much likelihood of its use in small installations, such as in domestic heating, motor vehicles, or railroad locomotives. The most effective application would seem to be in large stationary power plants or in large marine equipment. In any event, the development of general-purpose power-producing reactors is not anticipated in the near future.

For all of these reasons—the greater seasonal peak loads, the uncertainties of weather, the unpredictable behavior of unreported secondary inventories, the greater sensitivity to general business change, and the competition of other fuels—I think that we can expect the oil demands of the future to be less stable and to provide greater difficulties of prediction than in the past. But it is comforting to reflect that the total energy needs of the country are large and are growing larger. Liquid fuel is a convenient and desirable form of energy, and I believe that it will continue to seek and find expanding outlets in the highly competitive

energy market of the Nation. From the standpoint of the long-term investor in petroleum securities, that is an outstandingly important consideration. I believe that the growth factor in the oil business will continue to be with us for a long time to come.

But we would not be well advised, in view of the shifting nature of the business from a predominately gasoline business to a diversified energy business, to expect the same degree of stability in future demands that we have had in the past. There will no doubt be periods of disappointment and concern when bad guesses are made and supply and demand relationships get out of balance. At those times, it will be well to remember that the industry is a flexible and progressive sector of the free enterprise system, and has often demonstrated an ability to adapt itself to new and novel situations. As long as the industry retains its dynamic nature—and I am sure that it will—I have no concern about its ability to take in stride the competitive adjustments and the unexpected variations in demand that lie ahead.

* * *

President Jenks: Thank you very much, Dr. Brown. We greatly enjoyed your most helpful, thought-provoking, and enlightening talk.

Ladies and gentlemen, I thank you all for being here this evening and hope that you too feel that we have shared a stimulating, long to be remembered day. Good night!

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WILMINGTON, DELAWARE

COMMERCIAL SOLVENTS

Review of 1951

The following are highlights of CSC's activities in the year just ended. 1951 was a year of continuing growth and diversification. New products were introduced and new markets were developed. Production facilities were enlarged and sales forces were expanded. Sales of Commercial Solvents' six product divisions reached an all-time high.

Plant Expansions

An antibiotic feed plant at Peoria, Ill., was completed and put into production for the manufacture of Baciferm.

The new nitrogen solutions plant at Sterlington, La., started in 1950, was completed and placed in operation.

Antibiotic production was increased 3 to 4 times and unit production costs were sharply reduced with the completion of another antibiotic plant in Terre Haute, Ind.

A \$20 million expansion program at Sterlington was begun to double ammonia and methanol production facilities and provide a unit to make ammonium nitrate. Engineering and construction are already under way.

Under construction is a plant in Terre Haute to produce dextran, a blood volume expander.

New Products

Compenamine, an entirely new type of penicillin, was introduced. The importance of this product lies in its virtual elimination of allergic reactions.

Expandex, CSC's trade name for its dextran product, was manufactured in pilot-plant quantities and supplied for Government stockpile.

Baciferm, a bacitracin antibiotic feed supplement which is effective in stimulating growth, reducing mortality, and improving the market

quality of poultry and swine, was supplied to the feed trade.

Dilan, a new synthetic insecticide, was placed on the market. Of particular value in controlling the Mexican bean beetle, it has a wide range of usefulness.

The marketing of nitrogen solutions, under the name Dixsol, to the fertilizer industry was begun.

Among other important products introduced during 1951 were Tolamate, a hypertensive agent, and a diagnostic aid called Dia-Discs—both for the medical profession.

Organization Changes

In line with the broadening scope of the company's activities, the research, production, and sales organizations were enlarged and streamlined.

New groups established include Veterinary Medical Services, Nutritional Research, Chemical Market Development, Production Development and Quality Control, and three new geographical production divisions.

Financing

In September, arrangements were completed to borrow privately \$25,000,000 on 3¾% notes maturing September 1, 1972. These funds are being obtained to finance the expansion program of Commercial Solvents.

Commercial Solvents Corporation

EXECUTIVE OFFICES: 17 EAST 42nd ST., NEW YORK 17, N. Y.

The logo consists of the letters "CSC" in a bold, sans-serif font, enclosed within a dark oval border.